MICROBE

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# Smart City and Analytic: Quality of Life, Pandemic and their Neuro-Analytics in Green City Planning and Development

## MICROBE

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## 1. SUSTAINABLE CONSTRUCTION INVESTMENT, REAL ESTATE DEVELOPMENT, AND COVID-19: A REVIEW OF LITERATURE IN THE FIELD

The consumption figures by buildings around the world are some 30–40% per year [1]. Another study conducted by McAuley and Behan [2] showed that consumption of minerals taken from natural resources by the construction industry reaches as high as 50%. Such consumption produces around 33% of atmospheric CO2, which accounts for 40% of all energy coming from construction as well as from building operations globally. Meanwhile Petri et al. [3] report that the building sector of the EU accounts for over 40% of the energy and CO2 emissions throughout Europe. Leading in total global energy consumption is the building sector at around 30–40% of the total, according to Garshasbi and Santamouris [4].

A drop of some 3% worldwide in real gross domestic product (GDP) is expected by the International Monetary Fund (IMF). This constitutes a 5.9 percentage increase on the 2019 growth rate of 2.9 percent. The construction industry is bound to respond differently respective to the global region of operations. The United States now faces massive job losses in construction as well as in other sectors. Meanwhile, construction is expected to shrink in Southern European markets over a 60–70% range. In contrast, the economy of China, which includes the construction sector, has rebounded for the most part, indicating improved conditions. The data has shown an upswing since around last March/April [5].

The first wave of the COVID-19 crisis in the euro area resulted in construction companies operating at an estimated 25% to 30% below normal capacity. This was the period when communities were placed under maximally strict lockdowns. Nonetheless, conditions across the EU were very varied. Therefore, when operations were again allowed in the building industries, companies faced numerous difficulties. Apparently, the lockdowns and travel bans had caused labor deficiencies, breakdowns of supply chains resulting in construction material shortages, and strengthened health and security procedures that raised costs [6]. The first wave had impacted the construction labor market very greatly, especially due to temporary layoffs and reduced hours. The EU construction sector indicated a greater than 20% risk rate of experiencing such temporary layoffs and/or reduced hours in Q2 of 2020 [7].

The expectation regarding the effect brought by the second wave considered the time factor for adjustments to be made by firms regarding their security, which would lessen problems due to lessons learned. Furthermore, lockdowns were now better defined, so expectations were that supply chains had adjusted and shortages of inputs had been eliminated. It was thought companies would now have better security than they did under Spring 2020 conditions during the first wave [8]. The recovery in the industry showed a 97.5% rebound compared to the pre-crisis level during February 2020 regarding building production levels in November 2020 [9]. There was a V-shape to the overall recovery of the construction sector. However, total recovery of the industry back to pre-crisis levels during 2019 are not expected prior to 2023 [10]. Nonetheless, the recovery will differ considerably from state to state by speed and intensity due to the varied effect of the pandemic on industries operating in different states [11].

Many new publications on COVID-19 have appeared within the public-at-large since 2020. The effects from the pandemic hit the field of construction investment strategies, in addition to many other economic sectors. Rapid changes in behavior among investors appeared during the pandemic, becoming apparent in the construction sector and others. Remote work (meaning working from home) sparked greater demand for larger apartments/houses that would better accommodate the combining of work and personal lives within one facility. The impact on the retail sector is an upswing in demand for warehouses. Meanwhile, the administrative services sector faces radical changes in demand for operational space, which consequently launches an economy involving work sphere rearrangements.

This article provides the evidence of investments in construction behavior change due to the influence of COVID-19. By analyzing recent research, it can be seen that COVID-19 had a great impact on different types of property in different ways. The application of new technologies helps to solve a lot of problems that occurred during the COVID-19 period. This paper observes the future changes in the field

of real estate, including various asset segments, that will be brought about as a result of the COVID-19 pandemic. It discusses sustainable development guidelines and primary trends, which will depend on the pandemic spread and possible mutations from this time forth. The research elaborates the idea of real estate market changes. Historically, worldwide pandemics bring certain changes in the real estate segment. The current pandemic will bring with it the irreversible effect creating a different perception and attitude towards accommodation and commercial property in financial, socio-economic, and environmental terms. Aspects of sustainable construction investment and real estate development in the post-pandemic era, along with their trends and interrelations, are presented in Figure 1.1. These factors are briefly analyzed below.

**Figure 1.1.** Quantitative and qualitative investigation of sustainable construction investment and real estate development during and after the pandemic along with the formulation and validation of three hypotheses.

Legend:

1. Climate change trends (the new technologies introduced reduce usage of materials, carbon emissions, etc.)
2. Technological trends (digitization, smart amenities, increased use of technology by commercial real estate and accelerated adoption of digitally connected construction)
3. Security trends (stronger cybersecurity measures)
4. Economic trends (low interest rate, businesses faced with inequality, continuing issue of affordable housing, rise of alternative assets, lower demand for commercial office space, intra-regional investment, growing labor needs, rising material costs, and increased infrastructure spending)
5. Social trends (remote worksites with mobile access and utility management for remote work)
6. Demographic trends (continued population declines in major cities)
7. Urban development trends (increased demand for suburban life, household consolidation, and ongoing “smart city” developments)
8. Real estate trends (increased importance of rental property amenities, increased single-family rentals, focus on residential projects, changes in home ownership and customer-centric real estate)

9. Construction trends (industry adaptability and resilience, increased use of offsite prefabrication, 3-D printing, increased focus on green building, modular and offsite construction, and greater priority for indoor air quality)
10. Investment sustainability trends (environmental, social, and corporate governance (ESG) criteria to generate long-term, competitive, financial returns and positive societal impact)

Figure 1.1 presents the classification of a full range of real estate types: residential, commercial, agricultural, industrial, and special-purpose properties. The same or similar classifications are mentioned by many practitioners and researchers [12,13,14,15,16,17,18]. The classification can also be enhanced by including other aspects various researchers propose.

Wojewnik-Filipkowska et al. [19] note that various classifications of real estate are possible based on different characteristics. Based on structure it can be classified as land, buildings, or infrastructure, based on current usage it can be classified as residential, commercial, or governmental, based on importance in can be classified as either necessary or unnecessary for operations, while based on ownership it can be classified as owned by a school authority, a municipal housing company, municipal utilities, or a treasury department. One of the classifications considers the accessibility of urban facilities and services, which include hospitals, schools, educational centers, shopping centers, and recreational centers. This is a primitive factor, but the collection of available urban facilities can make a neighborhood either more or less attractive to a particular purchaser based on their household needs [20].

Real estate classifications can assist with portfolio selection, asset management, and performance appraisal, and there have been several attempts to find suitable groupings [21]. Traditional real estate classification models, as pointed out by Jackson and White [22], take into account the location and the level of economic activity within the sector relevant to the real estate in question. One classification was proposed by Graham and Bible [23] with age and condition; rental rates and occupancy rates; location; and construction quality as the four factors serving as the basis of their classification. Location, goodwill of the developer, and the quality of construction are the three points that Sehgal et al. [24] suggest should be considered in the selection of real estate assets.

Different real estate websites consider different perspectives when classifying nearby amenities available close to a piece of property. Life, health, catering, transportation, and education are the points considered by gz.fang.com, whereas gz.julive.com looks at hospitals, education, transportation, business, etc. Different approaches to classification of supporting facilities available nearby, however, do not mean classification lacks consistency. An important factor for real estate is convenience, and the classification of supporting facilities available nearby should include as comprehensive details of the daily commuting needs of residents as possible [25]. Kumari and Maan [26] analyzed image and scene (living room, kitchen, bathroom, bedroom, front yard, and backyard) classifications.

If a piece of real property scores high in the market's potential classification system, it attracts institutional and individual investors; when local authorities become more sensitive to the development of the area and the real property market receives a boost, the image of a city, community, or region can improve [27]. Mixed-use real estate, when a piece of property is used for multiple purposes, can also be added to the mix in the classification presented in Figure 1.1. An example would be both commercial and residential spaces available in the same building.

This study integrates different methods including the building life cycle method, environmental psychology theory, topic model, and some essentials of scientometrics, article level metrics, informetrics, bibliometrics, sentiment analysis, altmetrics, and webometrics.

Bibliometrics provides the method for analyzing bibliographic data taken from published literary sources, according to Pulsiri and Vatananan-Thesenvitz [28]. Thereby, it becomes possible to review an entire body of knowledge pertinent to a select field of inquiry. Bibliometrics makes it efficient to discover, arrange, and examine massive amounts of historical data, as Daim et al. [29] claim, which, according to them, assists in pinpointing "hidden patterns". Such patterns serve scholars in the process of making decisions. Meanwhile Porter [30,31] and Pilkington [32,33] actually classify materials taken from authors, organizations, countries, collaborations, co-citations, and other similar sources during the process of their studies as being pertinent to how bibliometrics can reveal hidden patterns. A reflection of the study of

disciplines and their dynamics appears in the production of their literature. The terms that reference this process in component fields are bibliometrics, scientometrics, and informetrics [34].

There is an informational definition of webometrics that is scientifically related. It incorporates quantitative aspects of construction along with applications of information resources, structures, and technologies, which Thelwall et al. [35] employed in their study. This study appears in the world wide web drawing pertinent to bibliometric and informetric approaches. The actual, original definition of webometrics that predominates in the field was established by Björneborn and Ingwersen [36]. They propose that it is the study of quantitative aspects pertinent to construction as well as the use of information resources, structures, and technologies referenced from the web, drawing on bibliometric and informetric approaches. Another definition was proposed by Thelwall [37] as the study of web-based content with primary quantitative methods. Its goal relates to social science research when employing techniques that are not specific to any one field of research.

No one indicator is able to satisfactorily measure the scientific impact of a multi-dimensional construct. Nonetheless, PLOS (Public Library of Science) has endeavored to achieve measurement by collecting and displaying a variety of metrics for all its articles since 2009. PLOS employed an array of different, categorized, article-level metrics (ALMs) and, at the same time, provided the same for the community-at-large. PLOS additionally collects different metrics, not only its statistics on the use of citations and usage, which measures the number of views and downloads pertinent to some articles. It also gathers data on the following: How many times has an article been saved in an online reference manager such as Mendeley? How many comments appear in the online discussions segment of an issued article? How many times does an article appear in a science blog or in social media? How often have other scholars recommended an article? Obviously, if only citations are considered, a wealth of this other information would be missed [38]. The three main categories for classifying scientometric indicators are journal indicators (JI), author indices (AI), and article level metrics (ALM). A frequently criticized impact factor is among of the most popular JIs, which additionally contain an article influence score, eigenfactor, and others. The h-index is the simplest and most popular of the AIs. However, AIs may also contain different variants such as the g-index, A-index, R-index, and others. There is a monotonous growth among most of these, named indicators, which do not include ageing. Certain efforts have been made to overcome this issue, such as the AR-index and discounted cumulative impact among other endeavors [39].

The online metrics measuring scholarly impact instead of traditional citations include altmetrics. Although altmetrics are commonly understood, there is no distinct definition of this indicator [40]. Quite a broad definition of altmetrics was proposed by Priem [41], as the study and application of scholarly impact measures based on online activity tools and environments. Meanwhile, the elements of online, scholarly impact traces refer to the altmetrics manifesto Priem et al. [42]. Definitions offered by Weller [43] are worthy of consideration. This scholar proposes that altmetrics include assessment methodologies pertinent to scholarly activities serving as citation-based metric alternatives. Weller [43] additionally proposes that assessment methods stemming from different user activities in social media environments are also altmetrics. However, Priem et al. [42] suggests that altmetrics usually describes alternative metrics to the established citation counts and usage statistics and/or metrics about alternative research outputs, not journal articles.

The discipline of scientometrics employs mathematical methods of quantifying the scientific research achieved by respective employees that unearths the scientific development process. Additionally, scientometrics provide a needed scholarly basis for scientific decision making and management [44]. Since scientometrics employs citation analysis and other quantitative methods for assessing scientific research activities, it can actually guide science policies [45].

Conventionally known modeling methods analyze formal texts, including papers, news, and blogs. Furthermore, these presume that topical factors alone generate links. Thereby topic-irrelevant links typically affect the learned topics of these methods on social networks. Artificial priors have recently been discovered to recognize links that the popularity factor in topic modeling generates. Nevertheless, such

methods are not able to capture the distinct properties of each link very well by using global priors. Thus, these continue to endure the effects of topic-irrelevant links [46]. Guo et al. [46] proposes overcoming such limitations with a unique social-relational topic model. This model analyzes the topics of relational users for each link, thereby lessening the effect of topic-irrelevant links.

An application of social media can be more meaningful when its analysis is taken from the writer's rather than from the reader's perspective in a classical sentiment analysis [47]. The affective topic model that Rao et al. [47] propose stems from their objective to bridge the gap between social media materials and a reader's emotions; therefore, they introduce an intermediate layer. The social emotions of unlabeled documents could be employed for classification purposes as well as for generating a social emotion lexicon by this described model [47].

The research's object consists of sustainable construction investment and real estate development, the contributing to it, and desire to fulfill its stakeholders' aims, COVID-19 condition, and external micro, meso-, and macro- level surroundings as a whole. A sustainable construction investment and real estate development subject model was established in order to achieve a detailed investigation of this object.

The target of investigation is the expansion of sustainable construction investment and real estate development effectiveness by applying a newly developed sustainable construction investment and real estate development topic model.

### 1.1. METHODOLOGY

The available literature on sustainable construction investment and real estate development pertinent to the current COVID-19 pandemic has been reviewed. This review is the topic of the present article. CIRED search keywords, which are later described, were employed for examining the Elsevier Scopus, Google Scholar, and Clarivate Analytics' Web of Science electronic databases along with other reliable and credible informational resources such as the American Society of Civil Engineers. Searches were restricted to studies published inclusively from 1998 up to 2021. A versatile quantitative and qualitative investigation on pre-, intra-, and post-pandemic sustainable construction investment and real estate development (CIRED) was performed by applying the building life cycle method, environmental psychology theory, topic model, and certain essentials of scientometrics, article level metrics, informetrics, bibliometrics, sentiment analysis, altmetrics, and webometrics. The introduction presents a brief description of these methods.

"Post-pandemic" analyzes seem to be quite popular globally. For example, such articles in Web of Science number 1025, in Google Scholar—26,700, and in ScienceDirect—31,535. There are also an ample number of such articles around the world, e.g., in the issues published by the Lancet [**48**,**49**,**50**], which forecasts trends for the year 2100. Additionally, the research results obtained from quantitative and qualitative analyses show that it is possible to forecast sustainable construction investment and real estate development during the post-pandemic period.

The intention for the design of the current review was initially to build bridges between academic research policymakers working in the field of sustainable construction investment and real estate development and the society-at-large. However, the COVID-19 pandemic prompted an undertaking to summarize literature available in the aforementioned fields regarding the concerns within these industries relevant to this illness. The composition of the central research enquiry is sustainable construction investment and real estate development, contributions to the same in the endeavor to fulfill the aims of involved stakeholders, the existing COVID-19 condition, and the external micro-, meso- and macro-level surroundings, all taken as a single entity. The following research questions were raised in an effort to analyze and write-up the CIRED big picture in detail:

Q1: Are the keywords relevant to construction investments and real estate development (CIRED) interrelated?

Q2: Do COVID-19 and pandemic-related national policies affect CIRED and its investors? Do investment strategies affect the spread of COVID-19?

Q3: Does the totality of an integrated analysis of the life cycle of CIRED, its investors, the pandemic context, and the micro-, meso- and macro-environment significantly improve the effectiveness of a CIRED analysis?

The basis for compiling the research hypothesis consists of the raised questions.

As part of this research, dedicated to the study of research literature, and the statistical analysis of relevant articles from a range of bibliographic databases, the CIRED Topic Model was developed in the following seven steps:

1. a search was done;
2. a 3D CIRED map was created;
3. CIRED-related papers printed in 2019–2020 and found by definite search keywords were compared;
4. a 1st Hypothesis on the distribution and correlation of keywords was proposed;
5. a colored document-frequency matrix was created;
6. two more hypotheses (Hypotheses 2 and 3) were proposed, validated, and linked;
7. micro-, meso-, and macro-level CIRED trends were established

Each of the steps is briefly described below.

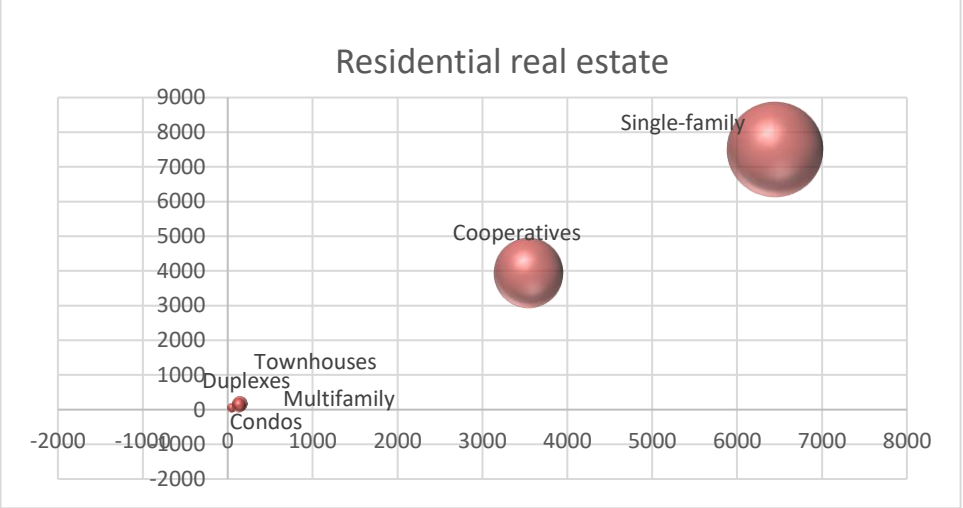
The first step involved a search for research papers in Web of Science, Google Scholar and Science Direct. A set of keywords was used for database searches and papers were selected based on a range of criteria such as construction investment, real estate development, civil engineering, COVID-19, sustainability, residential, industrial, commercial, land and special purpose real estate, risk, strategies, trends, and others. The scope of our search was limited to studies published in 1998 and later with the day of the search, 1 May 2021, as the end point.

Between 1999 and 2021, for instance, the Web of Science Core Collection database published 11,332 construction investment articles with the following number of papers in different Web of Science Categories: 1446 in civil engineering, 1381 in economics, 1132 in environmental sciences, 953 in construction building technology, 744 in environmental studies, 678 in green sustainable science technology, 543 in business, 541 in business finance, 436 in urban studies, 359 in regional urban planning, etc. The following items were published on CIRED: 6813 articles, 4338 proceedings papers, 255 reviews, etc.

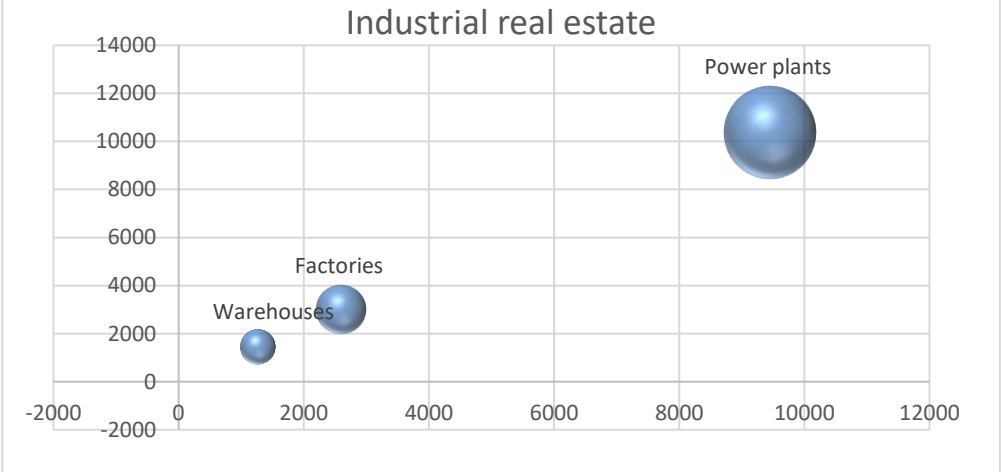
The paper is built on the keywords identified from readily available databases. These keywords from databases under deliberation are analyzed quantitatively (how many articles there are containing the keywords) and qualitatively (the main results obtained are written up in texts). Therefore, we hold the opinion that all the papers within the scope of CIRED research have been analyzed quantitatively and qualitatively by the use of specific keywords.

A 3D map, created as part of Step 2, is presented in Figure 1.2. The map is based on Elsevier's Science Direct database search results. The figure illustrates the similarities between various topics by showing their distribution over different keywords. All topics are labeled for the additional indication of the best way to record the semantics of the top keywords. For example, Figure 1.2 shows the keywords assume from 2019–2020 search for the following keywords: (a) residential real estate and investment, (b) industrial real estate and investment, (c) land real estate and investment, (d) commercial real estate and investment, and (e) special purpose real estate and investment. The size of each circle in Figure 1.3 represents the number of 2020 articles published in various Elsevier Science Direct journals based on the mentioned keywords.

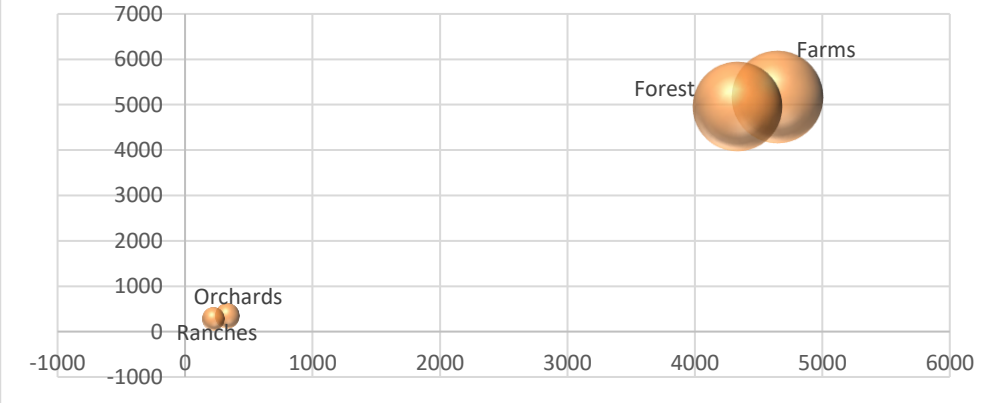
a)


Residential real estate
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-2000
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
Single-family
Cooperatives
Townhouses
Duplexes
Multifamily
Condos

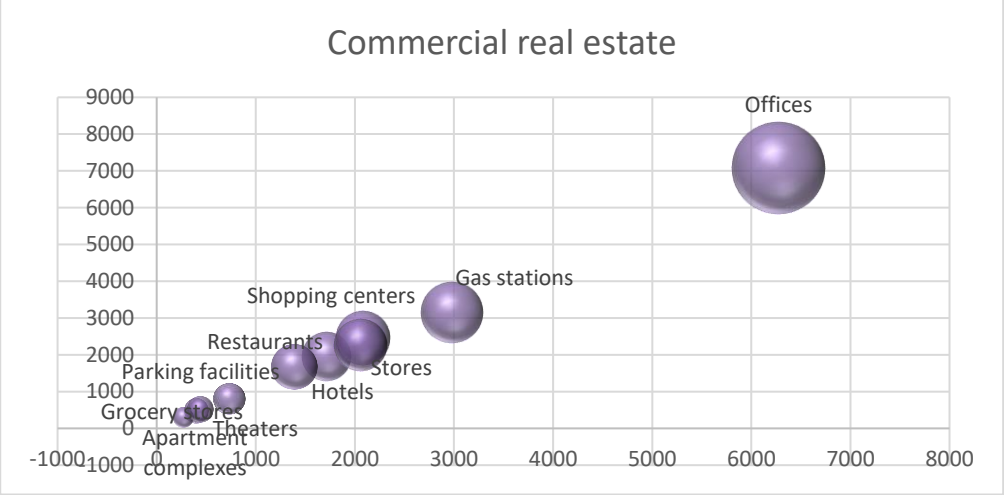
(b)


Industrial real estate
14000
12000
10000
8000
6000
4000
2000
0
-2000
-2000
0
2000
4000
6000
8000
10000
12000
Power plants
Factories
Warehouses

(c)


Land real estate
7000
6000
5000
4000
3000
2000
1000
0
-1000
-1000
0
1000
2000
3000
4000
5000
6000
Farms
Forest
Orchards
Ranches

(d)




(e)

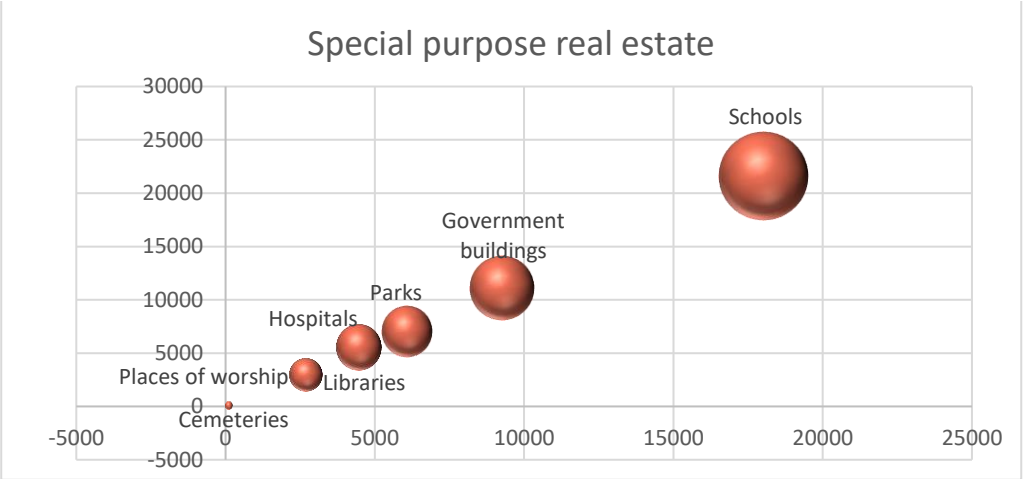
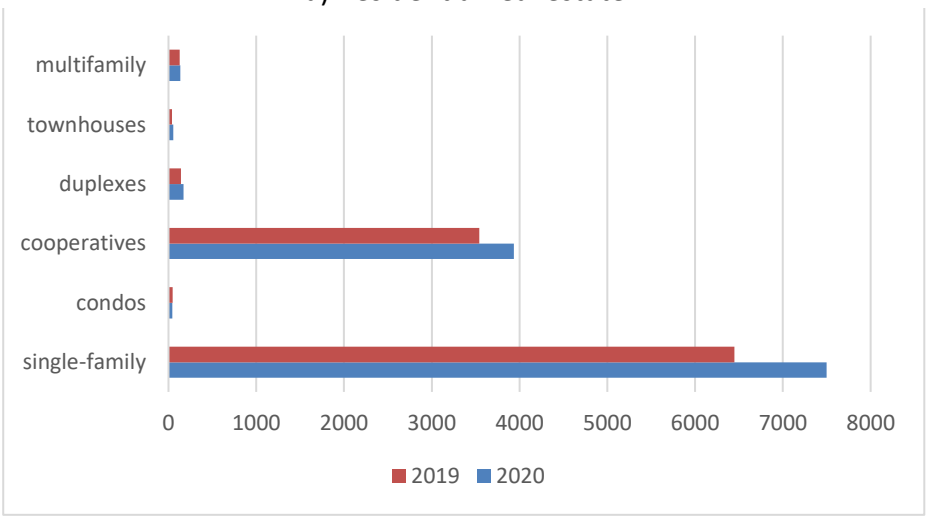
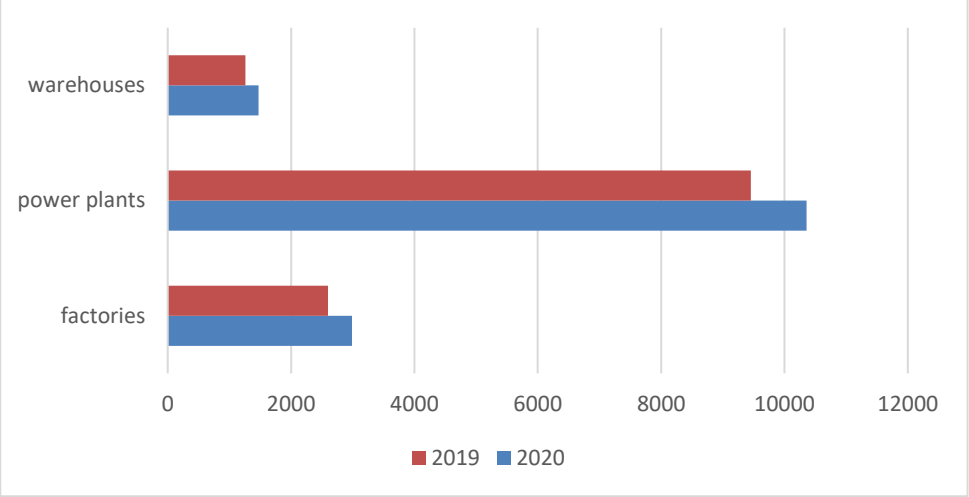



**Figure 1.2.** 3D maps with different-sized circles to represent the numbers of 2019–2020 articles published in the Elsevier Science Direct database for the following keywords: (a) residential real estate and investment, (b) industrial real estate and investment, (c) land real estate and investment, (d) commercial real estate and investment, and (e) special purpose real estate and investment.

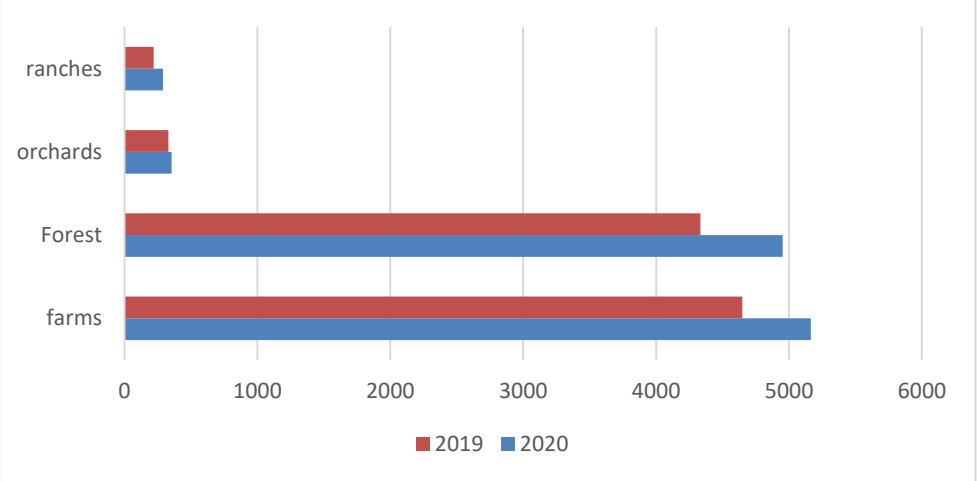
a) Residential real estate



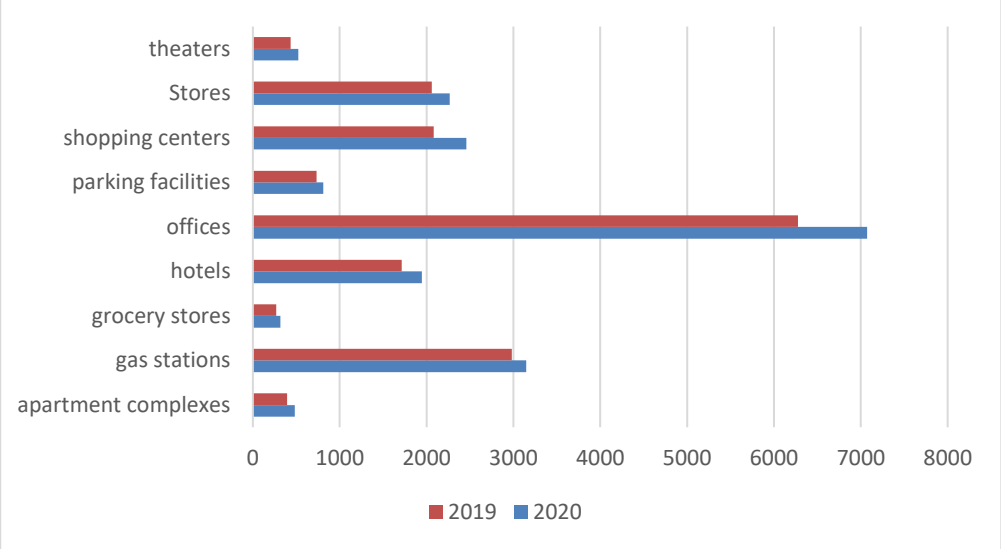
b) Industrial real estate




c) Land real estate




d) Commercial real estate



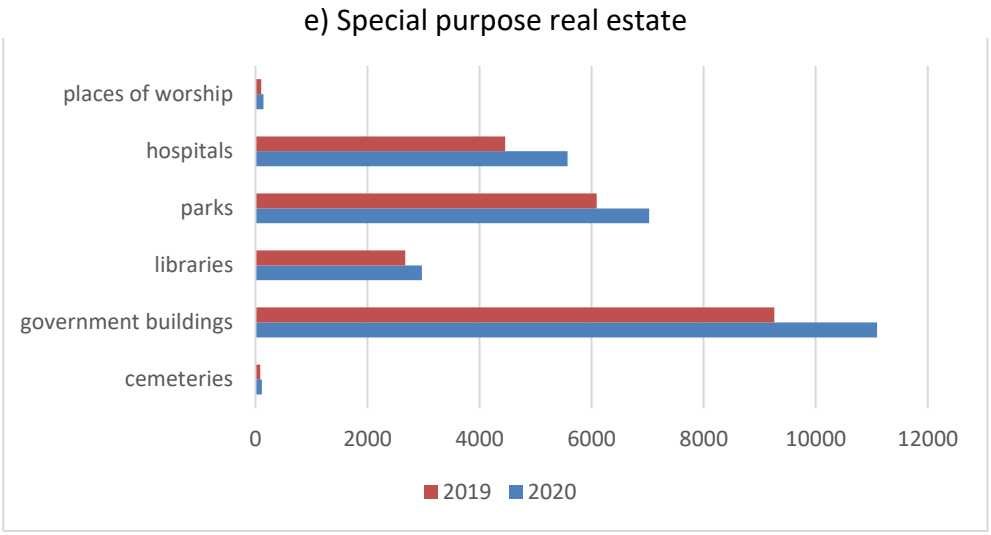



**Figure 1.3.** Collation of papers published in 2019–2020 in the Elsevier Science Direct database for the following keywords: (a) residential real estate and investment, (b) industrial real estate and investment, (c) land real estate and investment, (d) commercial real estate and investment, and (e) special purpose real estate and investment.

The compilation of the 3D map is in a three-dimensional sphere. The X axis displays the 2019 results, whereas the Y axis displays the 2020 results. The Z axis, where the number of 2020 searches is suspended, is reflected by the size of the bubble (scope of the search).

Step 3 involved a comparison of papers printed in 2019–2020 in Elsevier Science Direct found for the following keywords: (a) residential real estate and investment, (b) industrial real estate and investment, (c) land real estate and investment, (d) commercial real estate and investment, and (e) special purpose real estate and investment. The total quantity of papers printed in Elsevier Science Direct in 2020 was 15.61% higher than in 2019 based on the mentioned keywords.

Step 4 involved presenting and validating the distribution and correlation 1st Hypothesis of keywords. As suggested by investigators working in this area, topic relation meters are a qualitative approach for automatic uncovering of a topic's coherence [51,52]. The underlying idea stems from the linguistics distributional hypothesis [53]. In addition, keywords with comparable meanings have a tendency to appear in almost identical circumstances. Topics are considered coherent any time all or most words are related between themselves [54]. This research also proposed hypothesis 1 (see Table 1.1).

**Table 1.1.** Strong correlation coefficients gained among residential real estate and commercial real estate.

| | **Residential real estate** | | | **Commercial real estate** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **single-family** | **cooperatives** | **apartment complexes** | **gas stations** | **grocery stores** | **hotels** | **offices** | **parking facilities** | **restaurants** | **shopping centers** | **stores** | **theaters** |
| single-family | 1 | 0,998857609 | 0,99388799 | 0,954403551 | 0,954403551 | 0,993192574 | 0,993628616 | 0,97575933 | 0,983551995 | 0,993653389 | 0,994720214 | 0,913005767 |
| cooperatives | | 1 | 0,993160446 | 0,984543879 | 0,960366376 | 0,993459236 | 0,991286491 | 0,978740358 | 0,985521474 | 0,995148577 | 0,996037263 | 0,909229002 |
| apartment complexes | | | 1 | 0,98971233 | 0,957624301 | 0,984941956 | 0,982602524 | 0,984506485 | 0,978254443 | 0,992578623 | 0,988343034 | 0,881230379 |
| gas stations | | | | 1 | 0,940822182 | 0,967460598 | 0,977432403 | 0,978857917 | 0,964507344 | 0,981760469 | 0,980088551 | 0,840560341 |
| grocery stores | | | | | 1 | 0,963407374 | 0,923667713 | 0,977025896 | 0,981813038 | 0,972979144 | 0,972010935 | 0,854483561 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| hotels | 1 | 0,98542 4609 | 0,97395 3815 | 0,98754 3981 | 0,9912980 56 | 0,99300 4255 | 0,92805 1521 |
| offices | | 1 | 0,95497 7303 | 0,96385 9502 | 0,9808428 39 | 0,98267 5265 | 0,91619 6969 |
| parking facilities | | | 1 | 0,98282 4235 | 0,9864977 21 | 0,97996 3454 | 0,85273 1323 |
| restaurants | | | | 1 | 0,9888557 26 | 0,98932 029 | 0,89865 398 |
| shopping centers | | | | | 1 | 0,99410 5605 | 0,89403 3416 |
| stores | | | | | | 1 | 0,90588 9551 |
| theaters | | | | | | | 1 |

**Hypothesis 1 (H1)**

*CIRED-related keywords show strong mutual correlations.*

The matrix presented in Table 1.1 shows strong correlations between CIRED-related residential real estate and commercial real estate (Table 1.1).

The correlation analysis showed that the number of articles found according to the question posed for a search correlated. This indicates that the concepts selected for posing the search question were accurately chosen to reflect the selected subject matter suitably and fully. Furthermore, it can be asserted that the articles are interrelated and reflect associated matters under examination.

Other search terms also show strong correlations, which prove the right search terms were selected for the big picture analysis related to pre-, intra-, and post-pandemic CIRED. This study also confirmed the distributional 1st Hypothesis that the CIRED-related keywords show strong correlations with each other.

Step 5 involved creating a colored document-frequency matrix. Its columns and rows are presented in Table 1.2. The columns list the keywords for investments in residential real estate and commercial real estate and the rows show the quantity of papers discovered in Science Direct by concrete keywords. In 2020, 2266 articles containing the keywords investment and stores were published in the Science Direct database, and 2060 such articles were published in 2019. Each number is in a color-coded cell of the matrix, where the color represents a certain number of published articles: darker colors indicate higher counts.

**Table 1.2.** Keywords for investments in residential real estate and commercial real estate and color-coded cells where the color indicates the number of published articles (darker color means more articles).

| | Residential real estate | | | | Commercial real estate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| year | single-family | cooperatives | duplexes | apartment complexes | gas stations | grocery stores | hotels | offices | parking facilities | restaurants | shopping centers | stores | theaters |
| 2020 | 7499 | 3936 | 170 | 483 | 3146 | 317 | 1945 | 7072 | 809 | 1686 | 2458 | 2266 | 522 |
| 2019 | 6449 | 3541 | 141 | 395 | 2983 | 270 | 1715 | 6276 | 733 | 1387 | 2082 | 2060 | 435 |
| 2018 | 6040 | 3282 | 152 | 380 | 2838 | 226 | 1480 | 6061 | 584 | 1239 | 1920 | 1812 | 391 |
| 2017 | 5836 | 3076 | 159 | 371 | 2923 | 176 | 1475 | 6275 | 572 | 1095 | 1848 | 1712 | 371 |
| 2016 | 5289 | 2909 | 134 | 321 | 2291 | 182 | 1420 | 5730 | 572 | 1141 | 1671 | 1507 | 412 |
| 2015 | 5045 | 2779 | 113 | 273 | 2006 | 186 | 1376 | 5518 | 395 | 1045 | 1572 | 1533 | 405 |
| 2014 | 4456 | 2521 | 123 | 232 | 1993 | 151 | 1203 | 5037 | 385 | 948 | 1444 | 1402 | 327 |
| 2013 | 4091 | 2324 | 99 | 227 | 1763 | 125 | 1055 | 4538 | 344 | 863 | 1285 | 1251 | 314 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | 3553 | 2080 | 105 | 216 | 1415 | 108 | 1024 | 3889 | 282 | 703 | 1170 | 1073 | 307 |
| 2011 | 3267 | 1782 | 89 | 159 | 1258 | 90 | 922 | 3625 | 240 | 721 | 992 | 942 | 320 |
| 2010 | 2849 | 1716 | 92 | 129 | 1049 | 100 | 771 | 3257 | 210 | 611 | 951 | 902 | 358 |
| 2009 | 2662 | 1610 | 65 | 128 | 906 | 90 | 811 | 3115 | 173 | 551 | 870 | 879 | 299 |
| 2008 | 2670 | 1661 | 103 | 117 | 858 | 105 | 897 | 3183 | 211 | 693 | 990 | 895 | 308 |
| 2007 | 2442 | 1486 | 104 | 114 | 793 | 108 | 816 | 2937 | 204 | 562 | 873 | 831 | 310 |
| 2006 | 2159 | 1426 | 65 | 87 | 673 | 79 | 765 | 2746 | 160 | 518 | 887 | 682 | 296 |
| 2005 | 1848 | 1198 | 72 | 79 | 608 | 66 | 624 | 2456 | 119 | 378 | 684 | 591 | 198 |
| 2004 | 1773 | 1207 | 82 | 89 | 696 | 78 | 616 | 2426 | 159 | 382 | 737 | 631 | 207 |
| 2003 | 1740 | 1172 | 87 | 64 | 684 | 60 | 553 | 2233 | 120 | 396 | 696 | 632 | 175 |
| 2002 | 1440 | 1028 | 82 | 55 | 571 | 63 | 488 | 2075 | 108 | 335 | 684 | 511 | 156 |
| 2001 | 1593 | 1123 | 63 | 55 | 505 | 62 | 525 | 2033 | 102 | 390 | 696 | 526 | 158 |
| 2000 | 1315 | 981 | 60 | 54 | 597 | 49 | 442 | 1848 | 96 | 312 | 586 | 415 | 129 |
| 1999 | 1131 | 889 | 61 | 40 | 545 | 39 | 380 | 1619 | 106 | 269 | 514 | 368 | 125 |
| 1998 | 1105 | 897 | 51 | 44 | 545 | 56 | 415 | 1669 | 82 | 280 | 505 | 364 | 113 |

The basis for compiling Table 1.2 is the number of search results. The keywords entered into the search field are “residential real estate” and “single-family”, “residential real estate” and “cooperatives”, “residential real estate” and “duplexes”, etc. The Web of Science and Scholar databases were employed for the analysis. It was noted, while conducting the Altmetrics analysis, that the number of search results is not submitted when, e.g., directly searching a Facebook or Twitter page. The filtered flow is constantly renewed. Thereby the Altmetrics analysis was performed by employing Google’s search system by additionally entering the keywords “Facebook”, “Twitter”, “Wikipedia”, and “Scienceblogs”. The sentiment analysis was performed by employing different search systems (Google, Yandex, Yahoo, and Bing) and additionally entering “positive” and “negative” keywords.

Upon analyzing the gathered data, it was established that the number of academic articles, according to the selected keywords, increased in all subject areas over the period under analysis. However, the average rates of such an increase varied by different subject areas. The number of articles published in the area of land real estate showed the most rapid increase. The number of articles published in this field annually increased, on average, by 10.1 percent over the period under analysis. The slowest growth was established in the field of commercial real estate. Here, the number of academic articles increased, on average, by 7.6 percent annually. The rapid increase of academic publication in the area of land real estate may be due to the fact that this field had the lowest number of publications initially. Thereby, authors may have wanted to fill the informational gaps in this field.

The analysis of articles in the field of residential real estate revealed that the greatest increase in the number of articles appeared in 2020 as compared to 2019, which arose under the keywords of townhouse (28.6 percent) and multifamily (24.6 percent). Thus, it can be concluded that there was an increase in the interest of scholars in multi-unit, residential buildings during the pandemic. Upon performing the analysis of articles in the field of industrial real estate, the articles that increased in number the most during 2020 were those associated with warehouses (17.1 percent). Thus, it can be concluded that the authors writing about the topic of real estate development paid the greatest attention to warehouses. This can be explained in the sense that the role of warehouses became more important during the pandemic to ensure the uninterrupted flow of supply chains.

The greatest increase in articles on the subject of land real estate during 2020 were those in which the keyword forest predominated (31.4 percent). The explanation for this is that an interest in environmental protection and sustainable development grew during the pandemic since the stoppage of different manufacturing over the pandemic clearly showed the negative effect of industry on the natural environment.

The analysis of articles pertinent to the subject of commercial real estate revealed that the greatest growth occurred in articles containing the keyword restaurant (21.7 percent). Such an interest could be explained by the fact that the food services industry was one of the most negatively affected branches during the pandemic.

Meanwhile, articles pertinent to the field of special purpose real estate that grew the most over the year were those pertinent to places of worship (40.8 percent). Such growth during the pandemic might be explained by the fact that such places attract many people. Additionally, such places are associated with faith and hope, which are highly meaningful for people. Therefore, such places of mass gatherings during the pandemic meant a great deal to people, and the safety of people had to be assured at these sites.

In summary, it can be asserted that, during the pandemic, the greatest attention of authors writing in the field of construction investments was aimed at assuring the safety of people in construction and at construction sustainability.

Step 6 involved a methodical analysis looking for links between CIRED and COVID-19 to examine the hypothesis regarding the connections among the pandemic, COVID-19 -related national investment policies, and the behavior of investors along with their demands for CIRED. Two hypotheses were proposed in Step 6:

**Hypothesis 2 (H2)**
*COVID-19 and pandemic-related national policies affect CIRED and the interests of investors; furthermore, investing strategies affect the spread of COVID-19.*

**Hypothesis 3 (H3)**
*An integrated analysis of the life cycle of CIRED, the investors, the pandemic context and the micro-, meso-, and macro- environment as a whole significantly improves the effectiveness of CIRED analysis.*

To validate each hypothesis, the scientific literature from around the world was analyzed and a statistical examination of relevant papers accessible in the Web of Science, Google Scholar and Science Direct was performed. To achieve superior dependability of the supposed connection among pandemic, national CIRED strategies, and the behavior of investors related to their CIRED demands, the authors of this article introduced improvements to the research design. An investigation of worldwide research and a statistical analysis were carried out to validate the two hypotheses.

There can be quantitative content analysis that focuses on counting and measuring and/or a qualitative content analysis that focuses on interpreting and understanding [55]. Either type of analysis involves the categorization or “coding” of words, themes and/or concepts within texts by researchers who then analyze the results. The quantitative method of content analysis provides an opportunity for an explanation of, e.g., the intensity of the envisioning of certain topics and issues within the selected data resource. The number of articles is counted for each topic, except for the main topics of discovered articles, and/or the compatibility of such articles is analyzed. The result of such an analysis permits us to draw conclusions about the dependability of the supposed interconnections between pandemic and national CIRED strategies and about the behavior of investors relevant to their CIRED demands. Therefore, the analysis presented here is, strictly speaking, an integrated quantitative and qualitative analysis.

Step 7 involved establishing CIRED trends at the micro-, meso-, and macro-level by means of an investigation of research literature.

Based on the CIRED Topic Model, data and trends was obtained relevant to the conclusions.

## 1.2. CONSTRUCTION INVESTMENTS DURING COVID-19

On Web of Science (WoS), there has been a growth in the number of publications since 2020 about COVID-19 (more than 54,289 references since 2020: 2020 (27,945); 2021 June (26,320)).

Smart city means the use of different information technologies or innovative concepts for the connection of city systems and services as well as their integration into the city management and sustainable exploitation process in order to increase the effectiveness of the use of sources, to optimize city management and services as well as to improve the quality of life of the citizens. Due to their role in the sustainable management of the city, travel reduction and information spread, smart city projects were considered an important means of effective pandemic prevention and control by not implementing a strict lockdown policy [56,57,58]. The use of smart city platforms for wise prevention, epidemic control, information selection, and medicine resource adjustment while implementing the epidemic prevention and control attracted policymakers and researchers' attention [59].

A worldwide outbreak of COVID-19 caused enormous challenges to the governance of cities. It is a big question if smart city projects play an important role in COVID-19 prevention and control process. According to the approved data of COVID-19 cases and smart cities project investments in the cities of China, empirical results reveal that smart city projects essentially decreased the number of confirmed COVID-19 cases. Specifically, with an increased smart city investment of one million yuan per 10,000 people, the number of confirmed COVID-19 cases for 10,000 people decreased to 0.342. The results of heterogeneity analysis reveal that the influence of smart city projects on COVID-19 spread within cities is stronger than in the introduction stage. Besides, the impact is different in cities with different populations. Yang and Chong (2021) in their research provide quantitative proof of smart city projects' influence on COVID-19 prevention and control [59].

COVID-19 convulsions and the unprecedented financial outcomes caused huge uncertainty to future climate actions. Garel and Petit-Romec [60] analyze the cross-section of shares returns during COVID-19 convulsion in order to investigate the approach of the investors and their expectations on environment protection. The results reveal that companies that have responsible strategies in place regarding environmental protection experience better stock returns. This impact is mostly dependent on the initiatives intended to fight climate change (e.g., pollutant emission reduction and energy consumption), which are more notable in companies predominantly managed by long-term investors, which has not been noticed until the COVID-19 crisis. In general, the results reveal that the COVID-19 convulsions did not distract the attention of investors away from environmental protection issues. On the contrary, they encouraged them to take even more the responsibility for the climate [60].

Fourth industrial revolution (4IR) technologies appeared to be successful platforms, intended for communication and visualization of construction projects through team meetings. These methods can improve the monitoring of COVID-19 rules on websites. A detailed analysis has been carried out on the extent to which Nigerian construction contractors use 4IR technologies. Thus, this document deals with collective insight about the contribution made by COVID-19 to construction company problems related to the lockdown rules and the role of 4IR technologies. By considering the non-analyzed nature of the problem, a qualitative analysis method of virtual personal type was used. Twelve semi-structured interviews were made from the selected construction companies and expert consultants who summarized the data by using a topical method. The interviewed participants represented construction companies (six experts were from large construction firms and four from medium construction firms), one expert represented a mechanical engineering company, and one expert worked as a software consultant. The work experiences of the experts in their fields ranged from 15 to 35 years. The interviewed experts were CEOs, project and operation managers, a site safety officer, safety coordinating officer, chief maintenance engineer, and a software expert in construction equipment. The briefing was provided in the invitation letter for the interview. Letters of invitation were sent to intended participants, and 12 virtual interviews took place from late September 2020 to early November 2020. The face-to-face virtual interviews via video conferencing lasted between 45 and 60 min. Collated data were analyzed using thematic analysis. The conclusions divide 4IR technologies into a smart construction site, imitation and modeling,

digitization, and virtualization in the context of Nigeria, and most 4IR technologies can be useful in improving COVID-19 compliance. Unwillingness to implement, high implementation costs, inadequate management know-how, resistance to changes, etc. were revealed as the factors preventing the use of 4IR technologies. Conclusions will strengthen and provide a rich understanding of the impact of COVID-19 on construction sites and will help to notify the main interested parties in order to develop a favorable environment for 4IR technology implementation on site [61].

Barlas et al. [62] analyzed big data and investment in Turkey and extended the results to Spain, Mexico, and Colombia. The results of the survey for Turkey showed, that:

- The first important highlight is that the negative effects on investment caused by the COVID-19 shock have been neither as homogeneous nor as permanent as the 2018 financial shock, neither in sectorial data nor in geographical terms. The key reason for this is that machinery investment response has been more differentiated and dispersed and construction was not experiencing a previous boom this time.
- The response of construction investment has been more homogeneous, and it is also recovering faster so far than during the 2018 financial crisis shock. Facing a more negative situation prior to COVID-19 (as the construction industry was experiencing some de-leveraging consequences of the previous financial crisis), the initial response was homogeneous and amplified the already weak situation [62].

### 1.2.1. Property Types within Real Estate

Property kinds and property classes are identified in real estate. These two terms are different and should be approached as such. A real estate class indicates investment real estate characteristics and is often classified as Class A, B, or C. These classifications were developed by real estate investors, lenders, and brokers to provide the possibility of communicating and assessing the asset promptly. Any guidelines define these ratings and certain controversies may occur regarding the concrete asset.

On the other hand, the real estate class is classified into two main kinds of assets: commercial and residential. Residential real estate is considered real estate intended just for sustainable living. It involves one-family accommodation, townhouses, blocks of flats, and holiday houses. Residential real estate is regarded as an investment provided that the estate is not occupied by the owner and is owned for profit—through rent or its value increase.

Commercial real estate, or CRE, includes any asset that generates income. Types of commercial real estate include blocks of flats, retail, office, self-service warehouses, hotels, mobile houses, land, industrial, production, warehousing and delivery, and flexible space [63].

COVID-19 has had a different impact on the worldwide commercial real estate industry according to the jurisdiction or asset class. NEW JERSEY–7 October 2020-The Dodge Momentum Index increased by 3.7% to 130.8 (2000 = 100) in September, compared to 126.2 in August. The Momentum Index, issued by Dodge Data and Analytics, is a measure of the first (or primary) report related to nonresidential building projects assessed once a month that determines nonresidential buildings' construction expenses during the entire year. Both components of the Momentum Index increased over the course of a month. The commercial component increased by 3.9%, while the institutional component increased by 3.2% [64].

COVID-19 is not considered an existential threat to real estate. Real estate is mostly space where people stay. We need space for our work. In addition, at our core we are social beings. Thus, the need for real estate has not changed. The place of events has changed. People are working from home recently and tend to shop more online. However, people still need sustainable physical space. This requires flexibility. This does not show a reduction in demand [65].

Retail and office space did not prosper before the pandemic, and the situation got even worse during it. Certainly accommodation is not in demand, and apartments and student accommodation are in a bad situation. These are not just segments–the place of real estate is also important now [65].

Before the pandemic, about three-quarters of US retail areas had become unnecessary because of e-commerce and rebuilding. Lockdowns highlight that, and the shake phenomenon in retail will remain. However, retail that will continue will be incredibly efficient because the physically built retail will only supplement e-commerce and gain business advantages through multi-channel retail trade [65].

Moreover, investors should not treat all retail premises in the same way. The sale of food products is increasing, thus, shopping centers that are dependent on food shops are doing well. Closed shopping centers that hardly survived had already been on the way of reorganization - into concentrated mixed-used towns or otherwise. Essentially, some (but not all) shopping centers are not located in perfect places, thus, they have come to the point of reorganization into different purpose buildings. Simon Property Group, the leading owner of shopping centers in the US, had a conversation with Amazon about a conversion of department store areas into distribution centers. Shopping centers usually have perfect access to highways and are located in the vicinity of residential centers [65].

We will see tenants making long-term investments since people now acknowledge that COVID-19 is not going to be the last pandemic. Investors will jump to high-quality and sustainable real estate, and we see signs of that already. In order to control investment risk, think not only about the differences between real estate segments but observe entities or assets in a sector. You need long-term lessees who will stay for a long time. You need a good sustainable building in a good place in order for you to replace the lessee in case he leaves. You also have to find entities that do not need refinancing (expiring debt, or real estate may be used during a recession) [65].

### 1.2.2. Offices

COVID-19 focused our minds on the purpose of the office and to which extent it should be important in the policies and budgets development process of the company, besides, it highlights too clearly the strengths and limitations of home.

COVID-19 actually showed that a large part of work that is usually performed in the offices may indeed be performed outside them. Some realized that they can work more efficiently from home and are better able to enjoy their free time. Very few miss their morning traffic.

However, besides speeding up the work from home tendency, COVID-19 has also revealed its limitations—in know-how economics, the success of the organization will still depend on face-to-face interaction, cooperation, and coincidence. With common flexible work, the office may become a vital anchor. The office undoubtedly plays an even more important role in providing learning opportunities for younger staff. Exchanging work practices is not the only decisive factor. The International Monetary Fund has described the 'Great Lockdown' as the worst economic recession since the Great Depression in 1930 and predicts a setback at least as bad or even worse than the worldwide financial crisis of 2007–2008 [66].

The demand of occupiers will inevitably decrease, although this will differ in variant segments. The most aggrieved tourism and leisure industry will require less common space, while some professional services companies may go on operating with changed working practices. Rapidly growing segments, i.e., technology and electronic commerce, are already more geared towards virtual operation–according to Jack Dorsey, CEO of Twitter, employees can constantly work remotely if they want to [66].

Organizations have already begun reducing spaces so that each employee had less than one desk, and the recession is likely to accelerate this tendency. According to Magnusas [42], during the crisis, efforts are always made to reduce fixed costs, i.e., offices. A typical lessee will start thinking that probably they do not need any space for 100% of their employees, but only 75% or 60%. On the other hand, they might remain operating in the same area during and after the crisis [66].

COVID-19 is a bizarre phenomenon because of its sudden influence resulting in a push from organizations in the opposite direction—needing more space for one employee. Companies have been pressing more and more people onto the floor for a long time, and as little as 8 m2 per employee had become a typical density prior to the pandemic. For offices to reopen safely and maintain physical

distance, the proportion of employees per square meter or floor space will have to increase again, with changes to start times and continued remote working likely to take place [66].

It is difficult to say now whether we will ever feel comfortable again occupying space so close to others, thus, it is very hard to predict the long-term influence that physical distancing may have on office requirements. Perhaps a better question is whether organizations will want the same amount of space that they had occupied before. Now companies will know that they can operate with less office space. However, they will also find that they need better and more resistant office space [66].

What about the new office changes? Is additional space indeed necessary? This will condition supply and demand dynamics in local markets. In some areas, structural undersupply of modern, high-quality office space has already been experienced, and COVID-19 is likely to strengthen this, even if general demand remains the same. Changes may also take some time. As 'CBRE Canada' emphasized, commercial real estate is an outdated industry—two years have passed since the level of free offices reached the highest point after the worldwide financial crisis [66].

Since the revolution of working from home, which was caused by COVID-19 pandemic, will likely continue, investors are concerned about the lack of future sustainable office space demand and many are now thinking about alternative uses. Buildings suitable for alteration provide investors with more flexibility during the COVID-19 pandemic. This flexibility is very important when considering the increasing concerns surrounding the viability and profitability of office spaces, as well as other investments in real estate, in an environment where a large number of employees work from home and many will not return to their pre-COVID-19 work routines after the lockdown restrictions are lifted.

A study performed by 'O2 Business' in collaboration with 'ICM' and 'YouGov' reveals that "45% of the labor force in the UK consider that flexible work will constantly increase, and 33% predict that time of working from home will increase to at least three days a week". The increase in remote working will reduce the demand for office buildings, risking resulting in an increased number of vacancies [67].

### 1.3. REAL ESTATE INVESTMENT DURING COVID-19

Ref. [68] analyzed the impact of COVID-19 on the American economy from the perspective of job losses. By using a statistical method referred to as topic modeling and detailed datasets received from the Worker Adjustment and Retraining Notification (WARN) Act and a depository of seven million companies, the authors revealed essential conclusions about the most aggrieved US states and work segments. Since Arkansas, Colorado, Connecticut, Georgia, Kentucky, North Carolina, and Virginia indicate significant noncompliance with job loss models between the periods before and during the COVID-19 pandemic, the target number of jobs were lost in the recreational and philanthropic segments. Recently, the most aggrieved segments have planned longer lockdown periods or prepared for having fewer consumers instead of reopening [68].

A few observations noted during this research stood out. First of all, it is very important to understand that economic situations will change significantly due to the presence of COVID, i.e., some industries will be shocked, while others will be stimulated. Secondly, our conclusions reveal that some industries can actually remain buoyant as a result of the interaction of several social and economic factors. For example, contrary to expectations, aviation and retail (scoring S = 0.77 and 0.85, respectively) indicate fewer job losses during COVID-19. Thirdly, our study on job loss datasets reveals that people working in higher salary (suggesting elevated) positions have incurred a more negative impact than their colleagues on a lower salary. This could be the case because some jobs that come with a lower salary, such as working in food stores, maintenance, food preparation, security, etc., must remain functional during lockdowns. This research could widely influence public policymaking to strengthen economics and governmental subsidization of particular segments [68].

Ref. [69] suggested the study of real estate investment trust (REIT) funds' operational results before and during the COVID-19 pandemic in 2020 and chose a safety-first portfolio selection methodology in

identifying an optimal portfolio for investment between behavior levels (fearful-neutral-hopeful). The selection model was applied to the last 500 historical trade days and was used as a return scenario. The data check also covers the previous 100 days before and during the COVID-19 pandemic, and two standard markets were used (SPX and XLRE). The results of the research suggest that the US REIT investment fund is a better investment than XLRE, since it overtook the market during COVID-19 when investors stayed neutral. As a result of this research, scientists think that the conclusions can help investors to begin rethinking US REIT in their investment policies [69].

This study suggests a comparison of possible behavior return of each investor from fearful (P-0), neutral (P-0.5), and hopeful (P-1) by using a SF model before and after COVID-19. Market portfolios for testing by using the safety-first model are designated as P-0, P-0.5, and P-1 with hope being 1 and fear being 0. $\omega = \{0, 0.5, 1\}$ where $\omega$ is any number i from 0 to 1. As i approaches 1, an investor is more optimistic and hopeful. US REIT was selected as an investment fund, and two markets (SPX and XLRE) as the standard. Scenarios were estimated by considering 500 historical trade days, when the same returns were distributed. At the end of testing, the research revealed that the return on investments can differ depending on the behavior of the investor in the market and the selected standard indicative market. Furthermore, the pandemic had an impact on the results of testing. The REIT investment fund research result helps us to identify a good return possibility for investors during COVID-19, provided they are not neutral to return and risk. The researchers provide us with a case study on investments in REIT, and upcoming research may involve studying and determining the factors as to why REIT investment is a good investment regardless of the COVID-19 pandemic. Moreover, upcoming research may choose to test different standards in order to compare and analyze the results [69].

The influence of the COVID-19 pandemic on retail real estate and high streets was assessed in [70]. Although some variations induced by urbanization and digitalization have occurred over the last several decades, it seems that the COVID-19 pandemic accelerated these processes. We studied strategic events data on chosen UK retailers and insights of interviews with the retail asset managers and tenants of retail real estate business development and high streets in the UK. The conclusions revealed many tendencies, and some aspects stood out, e.g., distance from non-core assets, greater significance of asset choice, reconsidering of physical store function, ESG factors in asset and investment control, as well as clients involving a crucial factor for landlord selection. Our conclusions also emphasize different impacts on high street and urban retail. The work deals with emphasizes the prompt need to change the location of physical stores and involve digital platforms as principal functions of multichannel retail trade businesses. With more proof manifesting in the world after COVID-19, the upcoming studies should be concentrated on a more detailed consideration of the outcomes at the company and local level, as specified in this work.

Having considered the increased fluctuation and uncertainty in financial markets as a result of the COVID-19 pandemic in March 2020, we notice that retail investors reduced instant trade and increased contrary trade activity in the primary phase of this crisis [71]. We also notice that the influence of Robinhood investors on some market quality measures depended on the market conditions, suggesting better market quality during less tense periods and lower market quality in the course of the first weeks of the pandemic in the US.

It is anticipated that planning and construction decisions, as well as methods of investment, will vary after the pandemic [72]. It is anticipated that new attitudes to the economics of solidarity and space in city territories will be developed and new professions and business fields will soon develop. Accommodation markets will be stable, however, variations in commercial real estate markets will speed up. Most people will ambiguously distribute their capital to new long-term investments and will choose deposits, foreign exchange, gold, and other related securities investments and will be able to take up short-term investments. As a result, investments and manufacturing will reduce, growth will diminish, and an increase in employment will become impossible. Real estate and property owners and users may see changes in credit use, rents, and agreements [72].

People and real estate businesses should be prepared for upcoming disturbances by innovative technologies [72]. It is estimated that there will be an increase in smart buildings and technologies, which maintain less contact with buildings and structures. The number of shops in cities is decreasing, storage spaces in the city are increasing, and e-commerce marketing is quickly growing. With a decrease in administrative spaces in public and private institutions and office demand, home offices or flexible working hours may result in reducing companies' use of technology and employment. The digitalization of business and home life has become inevitable. New regulations will make all segments, especially banks, insurance companies, private pension systems, and other institutions structurize the real estate and asset management field [72].

The Italian real estate segment is experiencing an unprecedented situation that may have dramatic outcomes [73]. The extreme COVID-19 situation emphasized that household spaces are outdated in terms of their functionality, especially now that people are having to work from home and minors are having to isolate at home as a result of uncontrollable health risks. The residential and unlimited real estate markets, which used to be individual, are today intervened in. Thus, it seems that new market sectors may be identified and analyzed according to their key components and features.

### 1.3.1. Real Estate Operation

Official statistics from China show that housing prices grew dramatically between 2007 and 2014, but more moderately in recent years. According to the National Bureau of Statistics, China's total real estate investment was 0.36 trillion yuan in 1998 and increased to 10.98 trillion yuan by 2017, an almost 30-fold increase within 20 years. Existing data (from the China Wealth Management Product Market Development and Evaluation) shows that nearly 25% of trust funds flow to real estate, and housing price fluctuations lead to the conversion of properties from real asset attributes to financial attributes [74]. Real estate also accounts for a major part of financial assets within Chinese nonfinancial firms. Since the late 2000s, the government has increasingly shifted its focus to financial stability and the imbalances between finance and the economy. Under the central government's guidance, regulators have sought to stabilize housing prices through restrictions and limiting investments in real estate financial assets [74].

A successful investor takes up all possible actions to get a decent return. Investors make financial decisions based on the risk and return of various assets, however, other factors influencing investment benefits are investment goals, time perspective, safety of the main entity, future security, market environment, and heuristics [75]. Market environment is an important portfolio distribution factor; thus, a question arises regarding how the pandemic has influenced the decisions regarding portfolio distribution. The AHP results reveal that the preference for risky assets was higher than that for risk-free assets before the spread of COVID-19. Shares are a highly desirable form of investment. Since the COVID-19 pandemic, however, what counts as a desirable investment has changed. Risk-free assets are gaining more value. Insurance is the most desirable investment possibility, followed by gold, bank deposits, and public provident funds (PPF) [75].

Cities are constantly changing in terms of their physical and demographic qualities, as well as their social and spatial distribution [76]. For example, in the current COVID-19 pandemic, cities face many challenges such as constant abrupt tourism extinction (which can be a driver for gentrification and a significant part of the local economy) or the voluntary movement of richer people to their second homes in less populated areas, in addition to enhanced uncertainty about what will happen to cities in near future [76].

Ref. [77] analyzes the effects of the COVID-19 pandemic on commercial real estate prices. They report that retail and hospitality properties, and to a lesser extent office buildings, have been affected the most by COVID-19. The other sectors, in particular the residential and industrial sectors, have shown more resilience. Overall, prospects are significantly better for industrial and residential real estate and to a lesser extent offices than for retail and hotel properties. Prices are likely to depend more heavily and more

narrowly on the type and location of the assets, while current and future rental conditions should be taken into account to a greater extent in the risk premium [77].

According to a financial representative in Vietnam [78], as a result of the COVID-19 era, the real estate markets predict fewer revenues in the upcoming years. For example, REC-12 (Alavo Nghia) expects its income to amount to 166 billion VND, reduced by 24 percent compared to 2019, and the revenues before taxes amounted to 93 billion VND, reduced by 19 percent year-on-year. While struggling with this worldwide pandemic, most leading real estate investors in Vietnam have considered the integration of more 4.0 technologies in order to gain an apparent competitive advantage. Model results suggest that it is poised to have a huge impact on the real estate industry in Vietnam for the assessment of their past, present, and future comparative analysis with other competitors, especially during the COVID-19 pandemic, since it appeared that the pandemic had an essential impact on this industry. The authors hope that the results will reflect the present state of the real estate industry from the aspect of technical and technological effectiveness. Thus, the insights of this document could help managers, investors, and policymakers to upgrade their decision-making process and settle the main operation indicators in order to improve real estate for sustainable development [78].

### 1.3.2. Accommodation Prices

Although worldwide asset markets faced unprecedented risk and uncertainty as a result of the COVID-19 disease convulsion, the real estate market in most cities in the world proved to be secure regarding negative impact. Ref. [79] is the first effort to determine the impact of the pandemic on accommodation prices by applying a price gradient analysis to the COVID-19 epicenter in China. According to microlevel accommodation transaction data in 62 areas from nine districts in Wuhan City from January 2019 to July 2020, the hedonic pricing and the price gradient models reveal that soon after the pandemic convulsion, accommodation prices fell by 4.8% and 5.0–7.0% during one year, respectively. Although the accommodation prices raised after the lockdown period, gradient models reveal that the price gradients equalized from the epicenter to the urban periphery. The price rises also significantly reduced after the city went into lockdown in highly populated areas [79].

Since the real estate industry plays an important role in the economy of the country, public authorities should focus more on the impact of COVID-19 on accommodation prices and implement a complementary real estate policy [80]. By using data about the confirmed community-level COVID-19 cases in a month and the accommodation price in China, we can analyze the impact of COVID-19 on the accommodation price. The results reveal that in communities with confirmed COVID-19 cases, there is a 2.47% fall in accommodation price, and the negative effect can continue for three months, with the scope of the effect actually increasing with time. The effect of COVID-19 on the accommodation price manifests only in the regions with higher COVID-19 infection levels or high mortality rates [80].

### 1.3.3. Accommodation

During lockdowns, homes became a living and working space as well as an area in which to spend our free time [81]. Thus, homes were modified to meet the new requirements of communities that had to spend a larger part of their day at home. Soon, this will have an impact on the real estate market with respect to tendencies and features of desirable homes.

The performed analysis emphasizes the structural changes of residential asset demand in the Naples city area because of new requirements as a result of COVID-19. Today, cities face crises due to COVID-19, and this means that their spatial organization in particular is not suitable for bringing about the changes caused by COVID-19. The new identity of the post-pandemic city today reflects the long-desired transition aimed at for sustainability at different levels (energy, environment, and society). The performed analysis emphasizes certain structural changes demanded in the Naples city area because of new requirements as

a result of COVID-19 and reveals that changes in decision-making regarding the planning and construction of the settlements and investment methods are long-awaited.

Considering that the built environment is responsible for 39% of global carbon emissions, this situation could be used to tackle climate change, incentivizing and adopting renewal solutions from a greener perspective. In order to strengthen the contribution that the real estate market can make to the fight against climate change, it would be necessary to make the rules on sustainability in construction and the environment clearer and more feasible. This would strengthen the commitment of governments to this goal and increase their financial investment. Researching possible changes and opportunities following the pandemic, this study suggests that a change is expected in decision making about the planning and construction of settlements and investment approaches.

A UK study has shown how COVID-19 has led to changes in housing demands. For example, the increased prevalence of smart working has led to a growing focus on comfort and quality of the indoor environment. Better thermal insulation, acoustic insulation, visual comfort, indoor air quality, and the use of natural light are some of the factors identified by the aforementioned study as buyers' desires for improvement. These elements will lead to greater investments in measures to improve house performance, such as increased thermal or acoustic insulation (which, in turn, would lead to a reduction in CO2 emissions) [82].

### 1.3.4. Health Care

The COVID-19 pandemic has highlighted nursing home safety and infection control as critical public health issues [83]. The recent COVID-19 pandemic has substantially accelerated the attention towards health-centric topics globally in all industries, increasing the salience and relevance of healthy building in the real estate industry [84]. The shared understanding of a healthy building lies in its human-centered metrics.

With the change in the social and physical environment of socioeconomically and racially separated districts, these districts face a higher risk of gentrification and its effect on health equity (including fear, worry, stress, lack of sleep, worse nutritional habits, lower social cohesion, obesity, cardiovascular diseases or mental health problems, which, for example, all affect different groups of people more intensely) [76]. The intensity of the relationship with these health consequences and the significance of other potential methods, as well as their effect on health, will mostly depend on gentrification factors in a particular district or city.

Gentrification is affecting worldwide neighborhoods more and more. Hence, in order to come to a full understanding of the effect of gentrification on public health, it is very important to find out how different groups of people and kinds of gentrification, e.g., retail, ecologic/environment protection, climate, tourism, students, teaching, or health care, can have a distinct impact on health. However, the development of suitable measures, definitions, and measurements as well as access to data at a suitable geographic scope are still methodological challenges faced in the gentrification and health studies before they can be transformed into policy.

### 1.3.5. Offices

The discussion about the future of the office has taken on its own life since the implementation of lockdowns. The vitality and utility of the large-scale work at home/remotely/anywhere experiment has provided challenges and possibilities. To the extent that a traditional ecosystem of commercial property investment is a challenge, the vitality of traditional offices from the perspective of the suppliers and users, and even the future of city centers, have been assessed [85]. COVID-19 pointed to the human element regarding how and where work is carried out by considering the growth of the importance of the health and welfare of the employees and community. It also emphasized the work-from-home versus living-at-

work discussions. Many different participants with much experience and expertise in different aspects of established technological and workplace landscape solving, including health, welfare, anthropological, behavioral change, and sustainability factors, have participated in this paper. This wide scope holistic approach is the basis for the awareness increase, system models, and method proposals for achieving progress in the common real estate (CRE) space.

### 1.4. THE IMPACT OF THE COVID-19 PANDEMIC ON THE REAL ESTATE INDUSTRY

Public opinion shows that COVID-19 has had a significant impact on both accommodation and residential and commercial real estate industries. It seems that understanding restrictions on free movement imposed by governments will produce different insights into the importance of real estate for life and work [86]. Billio and Varotto [86] propose that the lower sustainability of the lease may change the sector of commercial real estate. However, the main change expected is related to the types and standards of buildings.

In this case, a comparison of stock market sector indexes is one of the ways to assess the potential impact of the pandemic on the financial sector [87]. Francke and Korevaar [88] suggest that the pandemic temporarily increased the risk of housing due to rising uncertainty and economic disruption. The authors assert that boosting prices are no longer significantly different from the average trend expected approximately one or two years after the end of the pandemic. The lack of any long-term impact on lease and housing prices is linked with city resilience to major shocks [88].

Although there is widespread talk about the negative socioeconomic impact of the pandemic around the world, still, a reluctance to look at the potential positive developments in the real estate market while facing one of the most acute diseases worldwide is displayed. Francke and Korevaar [88] clearly describe the example of Paris, where the pandemic proved to be a catalyst for significant urban change and housing prices recovered even in the most troublesome areas.

#### 1.4.1. Guidelines for Real Estate Following the COVID-19 Pandemic

The case of the Chinese real estate market, considered to be the focal point of the pandemic, demonstrates [89] that a decline in real estate value caused by the COVID-19 pandemic was to a greater extent influenced by social constraints and governmental anti-viral interventions to control the pandemic. Jovanović-Milenković et al. [90] agree that owing to threats to the life of the population and restrictions on free movement, the declining demand for real estate might be primarily affected by the population's desire to meet existential needs and maintain personal health [90]. Nicola et al. [91] find real estate uncertainty due to the COVID-19 pandemic to be another reason. Considering the measures of social isolation at the individual level, buyers and sellers are forced to rethink part of the sales process. As a result of insufficient data, the number of studies conducted is limited, however, both a study on housing prices in Italy [73] and the scientific literature suggest that the emergence of the pandemic did not bring about a fall in prices in the real estate area [91,92]. Billio and Varotto [86] prove that the major change in real estate relates to building types and standards.

Cities have historically been a major source of growth, development, and knowledge transfer. Gupta et al. [93] propose this long-term trend has changed as a consequence of the COVID-19 pandemic, which has prompted many residents to seek safer housing near urban centers. Most researchers consider how the COVID-19 pandemic could change the choice of households and residential areas. Due to mobility constraints, many urban residents living in urban centers lack a private yard, and the residents of remote suburbs, particularly those at risk, may feel isolated [94]. Gupta et al. [93] followed the example of the US from December 2019 to December 2020, when the prices of housing far from urban center areas rose faster than those in city centers. Thus, rental prices in suburban areas grew much faster than in urban center during the abovementioned period [93]. A study performed by the national association of real

estate agents Realtor concludes that residents preferred real estate with a private yard when purchasing residential housing [90]. Billio and Varotto [86] maintain that families having children will mainly look for independent real estate units such as detached and semi-detached houses with gardens and terraces, and households hoping to work from home may be encouraged to buy real estate outside the urban center where prices per square meter are usually lower, because, as stated by Belk [95], the need to live close to the urban center is reduced. Hence, the perception of the importance of free movement forms a priority for the acquisition of real estate in the suburbs near the biggest cities.

Scientists underline that the COVID-19 pandemic necessitates the redevelopment of existing residential buildings and construction of new buildings [92] that also meet sustainability requirements. A study conducted by Del Giudice et al. [73] also concludes and emphasizes that household spaces are functionally obsolete. Billio and Varotto [86] agree that spaces such as apartment entrances can be converted into a 'decontamination room'. In addition, D'alessandro et al. [96] point out that the transmission of the virus in the household is due to the inadequate housing construction and lack of necessary equipment. The researcher sets out recommendations for safe, healthy, and sustainable housing considering the newly designed and already available housing, including designing green spaces, the adaptability of premises, simple resizing of spaces, redesigning the principles of thermal comfort and indoor air quality, water and wastewater treatment, municipal waste management, the automation of building functions, and selecting appropriate building materials [96].

Apart from a significant impact on real estate prices, the pandemic will bring a different understanding of upcoming research on the real estate market, property search, and sales processes [90]. The author notes that the situation observed in the market has stimulated vendors to increasingly use remote communication tools such as virtual communication and 3D viewing, employing Skype or FaceTime to reduce the risk of infection spread [91,92]. Cheng et al. [89] state that the revolutionary platform Haofang XianShangGou, used during the time of social constraints, assisted customers by creating conditions for purchasing houses with reference to 360° photos, a personal viewing service that blocked purchasing actions performed by other consumers having selected a specific property to inspect, and even paying the deposit. Cheng et al. [89] propose that buying online in the real estate market is revolutionary. Over 8000 transactions were handled within five days of launching the Leju platform. Jovanović-Milenković et al. [90] emphasizes that some world banks started implementing real estate assessments based on virtual tours and approaches.

Fernandes [97] maintains that the pandemic has hit the hotel sector first. Short-term lease online platforms such as Airbnb will hardly reach pre-COVID-19 levels anytime soon [95,98]. The hotel sector has been adversely affected by cancellations, traveler distrust of security, and the introduction of social exclusion rules. Billio and Varotto [86] prove that the impact of the pandemic on the segment of this particular type of real estate will remain, as most companies have switched to online meetings, and the impact on the hotel sector will vary from country to country depending on the duration and severity of local travel restrictions and quarantine rules.

Although, as stated by Barua [99], the COVID-19 pandemic has had a significant impact on the real estate industry, recovery is subject to regional economic resilience, business types, and asset class. The authors of scientific literature agree that not all real estate has been treated equally during the pandemic [77,100,101]. It seems the assets that suffered most point to the areas of the highest density of people, and therefore we can expect most changes in this particular segment of assets. Billio and Varotto [86] remark that the majority of companies were more likely to use smart work solutions during the pandemic. Meanwhile, property owners and managers consider long-term solutions that will bring changes to commercial buildings to reduce the risk of forthcoming pandemics and thus bring them closer to the requirements of sustainable buildings. Researchers believe that considered changes may affect HVAC standards and the amount of enclosed space per person per square meter [86,101,102].

Tanrivermiş [72] makes the case that the Turkish real estate market shows that following the pandemic the offices of large cities will need to be redesigned, thus substantially changing the use of office

premises. The demand for smaller and home offices is expected to rise with the increasing use of virtual offices [72]. The author concludes that the application of different types of technologies in both business and residential segments will be inevitable. In that context, shops will be replaced with storage space, e-commerce will grow, and office space will shrink. The pandemic changes an employee's awareness of workplaces in the case that job specificity is not related to the workplace. The introduced restrictions on movement and social distance requirements forcing people to work from home may significantly change the demand for office space [77], because a large proportion of those working from home are likely to survive the crisis even after the pandemic. Restrictions on free movement, according to Carson et al. [94], have forced less technology-oriented sectors to relocate their activities to the internet, thus reducing the need for offices. As long as social distancing measures, which can be quite protracted, are necessary in the workplace, the space required per employee will increase significantly. This may lead to unexpected, significant changes in the demand for commercial real estate, but overall, a significant decrease in space is reasonably expected [94]. While looking for cost-effectiveness in creating workplaces, Billio and Varotto [86] accept that it would be much easier to create workplaces in the suburbs near residential areas where employees live. This would be much more cost-effective than investing money in the development of proprietary lease real estate.

### 1.4.2. Real Estate Prices Change Guidelines

A study by Oyedeji [103], following the example of Lagos, Nigeria, concludes that the COVID-19 pandemic affects real estate supply, demand, and sale and rental values. The majority of the surveyed respondents found the level of real estate transactions to be stable during the pandemic compared to the transactions handled prior to the pandemic. However, the level of supply and demand for industrial facilities (warehouses) increased during the COVID-19 pandemic. Oyedeji [103] and Apergis [104] propose that banking seems to be one of the prevailing problems in real estate transactions.

Considering the example of the Czech Republic, the conclusions of the real estate market analysis provided by Hromada [105] demonstrate that the real estate market frequently encounters delay. Immediately after the measures taken in the country to halt the spread of the pandemic in March 2020, the real estate market stagnated. Starting in June 2020, the market turnover of apartments for sale in the largest Czech cities increased and prices continued to rise. Hromada [105] states that the current prices are higher in and around Prague than those before the outbreak of the pandemic.

A further growth in the prices of apartments for sale is expected in the upcoming period. Hromada [105] identifies the following factors as determining price growth [105]:

- The central bank policy is a quantitative stimulus causing people to protect their capital for fear of inflation thus preventing from a drop in real estate prices even in the case of recession.
- A decrease in mortgage interest rates, lack of alternative investments to capital gains, and a failure in pension reforms.
- Builders seek to sell their products to foundations and corporations thus leaving 20–30% of the supply of apartments in the sales market. Therefore, the supply of apartments to the general public will be reduced. The missing or urgently required products are expensive.
- A shortage of foreign labor in the construction industry is observed, and the situation will hardly change. On the condition that foreign staff are replaced with local employees, the work done will become more expensive, and the price for the results of this work will increase.
- The aftereffects of the pandemic have hindered ongoing construction and delayed the process of issuing building permits. Hence, the output of new construction will rise more slowly.

## 1.5. GLOBAL CONSTRUCTION AND REAL ESTATE MARKETS BY COUNTRIES AND NEW SHAPES FOCUSING ON TECHNOLOGY, SMART AND GREEN INFRASTRUCTURE INITIATIVES

### 1.5.1. Global Construction and Real Estate Markets by Countries

At the start of 2021, global CRE market acquisitions fell again, marking the fourth quarter of pandemic-related declines in a row. A drop of 24% year-over-year was recorded in sales across the major income-producing property types, such as apartment, industrial, and office properties. The decline in deal volume, down 12%, was the lowest in the Asia Pacific region, explained by the fact the region had been the first to be hit by the coronavirus pandemic. The declines, around 25%, are sharper in Europe and North America. In 2021 Q1, only the apartment sector recorded an increase. All other property types experienced declines, with retail and office properties reporting the biggest ones [106].

The commercial real estate (CRE) sector was hit hard by the coronavirus crisis. As countries scrambled to contain the virus and economic activity was severely restricted, global commercial property transactions and prices fell in 2020. The hotel, office, and retail segments suffered a heavy blow and some of the effects could be permanent, as people who moved to online work may continue this practice in the future and other activities may move away from large cities [107]. Fendoglu et al. [107] believe that:

- The CRE sector suffered a heavy blow from the novel coronavirus crisis and possible structural shifts in demand add more uncertainty to the outlook for some of its segments. Enhanced supervisory attention is, therefore, warranted.
- Misaligned commercial real estate prices, especially with other vulnerabilities present, make the risk of lower future growth higher due to the likelihood of marked price corrections. Such corrections could hurt corporate investment and threaten financial stability. In this scenario, economic recovery would be hindered.
- Near-term policy support to stimulate aggregate demand and ensure the nonfinancial corporate sector access to loans will contribute positively to the recovery in the CRE sector.
- In the case of persisting large price misalignments, policymakers should move quickly to contain vulnerabilities in the sector with targeted macroprudential measures when required. Specific circumstances may also justify capital flow management measures to limit excessive cross-border inflows and the related potential risks.

The global COVID-19 pandemic has dealt a heavy blow to the manufacturing sector, forcing it to consider a sustainable long-term business plan ensuring economic, social, and environmental sustainability. An unprecedented need for higher value by the customer with fewer resources demands these considerations. To ensure long-term business sustainability, innovative integrated manufacturing practices, such as agile manufacturing and lean six sigma, are required. Simultaneously ensured waste elimination and adjusted dynamic changes in the requirements and demands, without compromising the quality, can help with achieving this goal [108].

Despite the serious pandemic-related slumps, the economic situation in the German construction industry is not wholly bad: investment in renovation of residential buildings and new construction is still rather strong and acts as a major boost to the sector. Commercial and public construction is, however, a different story, with many firms dealing with considerable drops in construction investment due to the pandemic. Uncertainty, a distortion of equity, and losses have led to reduced economic activity and additional production capacities are, thus, not required. Online businesses have prevailed over stationary retail. This may also lead to medium-term shifts in demand. However, it is still early to make predictions as to whether this change will last and to what extent it will reach [109].

Social distancing has been pushing more consumers to use e-commerce, and warehouses have become commercial property in high demand. In 2020, investors flocked to industrial properties, and, for the first time, the spending on American warehouses overtook that on office buildings. The market now shows signs of overheating. The coronavirus hit retail properties and hotels very hard, and offices also suffered because of the recommendations to work remotely whenever possible. Warehouses, however, are seen as more resilient property in a pandemic world. As money is pouring in, prices are rising: Real Capital Analytics Inc. reports that, in the 12 months through October, the prices of industrial properties

increased 8.5%. Meanwhile, the prices of retail real estate dropped 5.2% and those of offices remained mostly unchanged. Seen as an alternative to lower-yielding bonds and volatile stocks, real estate has become a popular investment target, and this year investments in industrial and warehouse properties accounted for 20% of global commercial real estate spending, compared with only 12% in 2015 [110].

US warehouses, self-storage, and technology were the best performing property types. As many people are working from home, the demand is high for high-tech facilities that host cloud servers and cell towers that transmit data. Retail real estate investment trusts (REITs) and hospitality showed poor performance. The likely cause are the combined effects of imposed lockdowns, cancelled travel, and stay-at-home orders in most locations. Underperformance was also noted in diversified REITs, because many hold multipurpose and retail properties. A drop in demand also affected owners of specialty REITs (e.g., agriculture, golf courses, casinos, and timber). Over the same period, residential and office properties were spared some of the negative effects and a possible explanation is relatively inelastic demand and longer-term leases [111].

Real estate and mortgage markets have been defined by Brodeur et al. [112] as a complex net of interconnected participants such as investors, developers, households, banks, and many others. The market is also characterized by links to financial markets and the overall macroeconomy. The COVID-19 pandemic has severely hit real estate markets. We can see its effects in empty shopping malls, abandoned flats in metropolitan areas, and vacant office buildings [100].

The currently available valuations data released by NCREIF and MSCI for Canada, Ireland, the UK, and the US show overall single-digit falls for office capital values in 2020. The falls for retail values were larger, in the double-digit region, whereas industrial capital reported single-digit increases in value. Different regions experienced different levels of real estate investment activity in the second half of 2020. After a sharp fall at the start of the pandemic, transaction activity is already showing signs of recovery in the Americas and Asia Pacific but remains weak in EMEA. In 2020, global investment activity totaled $726bn, 28% below the 2019 level. The last quarter of the year, as investors completed deals before year-end, saw all regions experiencing the usual seasonal pick-up in activity despite the ongoing pandemic. The sector differences observed in private real estate markets continue to be reflected in the listed market. The listed market data of FTSE EPRA NAREIT show that, in USD terms, global industrial prices by the end of January were 14% above the end-2019 levels, while offices were down 20%, residential 5%, and retail 27%. Less variation was observed at the country level, with falls of around 15% in the markets of Japan, Switzerland, the US, and Europe excluding the UK [113].

The real estate and mortgage market is connected to other credit markets, financial markets, and the macroeconomy by potential valuation and wealth effects. The negative effects are expected to lead to more vacant commercial real estate. Accompanied by increased uncertainty, these expectations of low growth lead to a drop in the value of commercial property portfolios held by private and public real estate investment trusts or developers, private equity funds, and high net worth individuals. This, in turn, leads to increased leverage ratios and a demand for higher risk premiums in future investments. Dropping property values make it harder for commercial investors to secure loans. The effect is exacerbated by dropping stock prices of listed real estate companies, which dries up funding liquidity further. Firms with less cash, more debt, and limited profits before 2020 show especially low stock prices during the coronavirus pandemic. Real estate securities are also among the lot [100,114].

With the COVID-19 pandemic continuing for four months already, the hotel and retail segments of the American commercial real estate market show signs of distress. The Q2 hotel deal volume, which dropped to $642.9m, or 91% year over year, is the lowest Q2 volume in RCA history. During the same period, hotel asset refinancing was down about 50%, compared with the same period of the previous year, and about 30% lower than in the previous quarter. According to RCA, the hotel sector has suffered a heavy blow: the Q2 total inflow of distress was more than three times higher than the average quarterly inflows of 2009. The second quarter saw a surge in reports of potentially distressed assets (the total for the first half of 2020 is $2bn), and the number is expected to rise. Distress sales for hotel assets are higher

than any other class of assets, according to RCA. In all Q2 hotel sales, the share of hotels being acquired out of distress was 4%. RCA said that “if the sector continues to see growing levels of forced sales, it may exit the ’shock and triage’ phase of the downturn and head to the ’price discovery’ phase at a faster pace than other asset classes.” Like hotels, the retail sector also suffered a blow and its Q2 transaction volume plunged to $4.6bn, or 73% year over year—a worse Q2 performance has never been recorded for the sector. The total Q2 inflow of distress was more than two times higher than the average quarterly inflows of 2009. The “pain does not appear to be ending” for the sector, according to RCA. A growing flow of reports of potentially distressed retail assets in Q2 led to a total of $29.4bn for the first half of 2020 [115].

US commercial real estate suffered a heavy blow from the pandemic, and the market was basically frozen for months: in the first three quarters, total transaction spending dropped more than 40% compared with the previous year. Hotels suffered the highest drop of 71%, followed by offices with a drop of 44%. The situation of industrial properties, in this context, looked somewhat better, their sales sliding down 25%. In terms of real estate spending among American investors, the first three quarters of this year saw the share going to industrial and logistics spaces at 24%, compared with 23% for office spaces, and for the first time investors spent more on warehouses than on offices. In view of a marked shift towards e-commerce, Jones Lang LaSalle Inc. forecast the demand for new industrial spaces will reach 1bn square feet by 2025. A construction boom that concerns some lenders is, therefore, to be expected [110].

The capital value for industrial assets was resilient in 2020 and can be expected to show an upward trend between 2021 and 2025. The situation of the COVID-19 pandemic is different from that of the 2009 financial crisis, when the UK experienced a sharp drop in prices (–41% between July 2007 and July 2009). People have been forced by the pandemic to spend more time at home and their wellbeing there, therefore, now plays a more significant role. This means households may now value properties more for certain characteristics (size and number of rooms, nearby services and retail, location, sunshine, and others) and even be ready to spend more of their budget on the home. These patterns will contribute to higher prices [77].

The new measures of suspended activities make no direct impact on German construction investments and the general environment that has a large amount of pent-up purchasing power, high demand for residential real estate, and low interest rates remains extremely stimulating, especially for residential investment. Beginning in 2021, the deterioration of public finances due to the pandemic will put a certain damper on public investment [116].

China experienced adverse effects with a 30.3% drop in fixed asset investment and a 16.3% drop in the real estate development within just the first two months of the year [117]. In China and other big economies, the construction sector suffered a serious impact from the COVID-19 outbreak. In view of this situation, GlobalData3 adjusted its estimate for construction growth in 2020 down from 3.1% to 0.5% [118].

The damage caused by the COVID-19 pandemic means that future asset renewal and hotel investment will focus more on the cash flow control and return on investment to maximize operating value and the value of a property [119]. Over the past 40 years, China has been developing at very high speed with a growing number of luxury hotels as a related outcome. With hotel investors suffering from significant pandemic-related losses, their future projects will be more return-driven and rational. Previously focused on big and comprehensive, investors will move to small and exquisite [120] and maximum possible revenue per square meter per minute will become the main return-optimization formula [121]. In the age of digital transformation, hotels have invested in computerized customer relationship management to make their customer service configurable and traceable and achieve the ability to improve membership conversion, provide customized services, predict the individual preference, and engage customers in ways that increase their loyalty. Revenue management and big data offer hotels ways to perform precision marketing by analyzing the travel distance of the target consumer, composition, and demand [122].

Due to the coronavirus pandemic, construction-related gross value added (GVA) is expected to shrink by 15–34% and employment by 11–25% in India because of a decrease of 13–30% in construction-related investment. This pandemic is expected to reduce both supply and demand in the construction sector. As a sector highly driven by infrastructure projects, construction is expected to suffer greatly faced with the loss of income, high uncertainty, dismal business, consumer sentiments, and the fact that government funding will remain focused on the management of COVID-19 [123,124].

### 1.5.2. Buildings Requiring New Shapes Focusing on Technology and Smart and Green Infrastructure Initiatives

The sustainable development goals reflect the need to maintain the same level or add more urban greenspaces open to public access, especially to marginalized groups. The importance of this goal has been emphasized by the COVID-19 pandemic. As a social and public health investment, urban public greenspaces should be considered a chance to balance our relationship with nature differently, looking to protect ourselves against future pandemics. Along with health benefits, such investments may also contribute to carbon sequestration, biodiversity promotion, job/food creation, and offer other beneficial effects [125].

Recovery policies, as stated by the International Energy Agency [126], should target investments in resilient and clean energy infrastructure; only then can countries avoid a rebound of emissions above pre-crisis levels, as seen after previous crises. The early stages of the COVID-19 pandemic, according to Helm [127], gave us a valuable lesson in the correlation between the decline in emissions and pollution and the decline in GDP. This correlation suggests that growing population and GDP will put our ability to meet the Paris Agreement limit of 1.5 °C for global warming at risk. The importance of a renovation wave is stressed by Vis [128] as a necessity in our efforts to deal with this invisible pandemic [129].

As the backbone of the American economy, infrastructure is critical to the country's prosperity and the health and welfare of its people. The quality and quantity of jobs in the US economy and families' disposable income (with a loss of $3400 for each household each year) has already suffered due to poor and outdated infrastructure. Investment in infrastructure is one way to make the pandemic-related economic burden lower for Americans in the long-term, as these investments will provide opportunities for Americans to return to work and benefit both large and small businesses. These investments will also help the economy keep moving, ensuring its speedy recovery from the pandemic-related economic shock [130].

Faced with unprecedented pressure caused by the COVID-19 pandemic and its adverse effects on budgets, US mayors should focus on infrastructure, with an emphasis on technology, as a means to give new energy to their local economy while keeping the spread of the disease in check. Despite the move to virtual and online services, investment in buildings/facilities is still necessary and should be a top long-term investment priority. The use of commercial buildings should take new forms with a focus on technology and smart infrastructure initiatives. The sense of urgency induced by the pandemic and the desire to curb the spread of the virus will make this a priority for many. Although these priorities, on the whole, look similar, investing in renewable energy solutions is a notable exception among long-term investment priorities. Mayors should make the creation of 'workforce of the future' jobs, smart technology deployment, and investment in the expansion of virtual/online city services their priority. The investment priorities for facilities and buildings are focused on creating COVID-safe environments for people. Many consider the time is now right for investment in transit-related capital projects to address longer-term needs. Job creation is a possible outcome, which proves that any investment is conducive to economic recovery [131].

Epidemiologically, serendipitous office interactions are, according to Mance [132], incompatible with the pandemic regimes of social and physical distancing. Offices, where large numbers of people work indoors in close proximity, make the virus a significant threat [133]. Shared computers and keyboards, hot

desking, shared workbenches, and other similar contemporary practices are a potentially threatening cross-contamination and breeding ground for pathogenic microorganisms, viruses among them [134,135,136]. This means the new COVID-19 and post-COVID-19 era challenges the now widespread practice of hot desking, open plan, shared space, co-working and ABW offices, and major changes as well as organizational investment in redesign are likely with businesses seeking to make their offices COVID-19 transmission control compliant and safe [137]. Their areas designed for staff movement, interaction and meeting, density of floor space occupancy, face-to-face workstation configurations, and promotion of staff movement within and between floor areas are all conducive to the virus spread [138,139]. If such designs persist, employers may not only face penalties for noncompliance with COVID-19 regulations, but office staff may also be unwilling to return due to the potential risk of catching COVID-19 [140]. Some organizations are already investing in COVID-19-compliant offices and adopting available technological strategies. Door-free entrances, handwave, foot or voice-activated doors and other innovations are among the technologies being investigated or considered. Some of these technologies can also be installed in elevators. Motion-sensor technologies, meanwhile, can also be used in bathroom faucets, cupboards, and light switches to limit surfaces that multiple people touch [133,138,140,141,142]. Smartphone apps can be used to identify failures to comply with staff distancing rules [143]. UV lights for overnight surface disinfection, enhanced air ventilation, improved filtration and occupancy indicators, and humidity monitoring are other instances of available enhancements for building management systems. Smooth surfaces ensure more effective cleaning, and nanoseptic cupboard and door handles offer continuous antiviral, anti-bacterial, anti-microbial, self-cleaning surfaces [138,140,144,145]. These technologies are already available and involve capital investments that now may require immediate expenditure, even though they may have been budgeted for gradual adoption over the course of multiple years before the pandemic [144].

Another option is a major redesigning of offices along with material processual and technological innovations, as an investment in community and employee health and safety [146].

A return to pre-COVID-19 investment patterns may turn into a loss if people and businesses are no longer interested in city centers. Broadband penetration and strong digitalization can be expected to amplify any lockdown habits and trends and act as increasingly important factors in location selection. Since lockdowns have been introduced, it is natural to see very few people using public transport, but it is still difficult to predict the way fear, habits, and other behavioral factors will contribute to transport demand after the pandemic. The sustainability of physical networks is an issue that has often been neglected, and related implications for the long term are especially important [147]. In the long term, changing transport networks and urban accessibility will affect the urban form and land gradient [148].

Company policies and work culture can be expected to change after the COVID-19 outbreak [149,150]. The construction sector will also expand its use of automatic machines. The clients are likely to move away from the property industry and towards a range of various industries such as logistics, artificial intelligence (AI), automation, e-commerce, and others. AI will become important in the analysis of the global construction market (detailed information on vendors and competition patterns), revenue, forecasting (vertical and geographical, development model, component, and service model analysis), and growth. Another important area of AI deployment will be to predict a project's cost overruns (based on the competency level of risk mitigation, the size and type of a contract, and automation) [151]. AI can also predict emerging trends and changes in customer behavior [152]. AI-enhanced drones will monitor construction sites [124].

## 2. COVID-19 AND GREEN HOUSING

The current health emergency has proven to be a crisis like none other recalled in modern times. There seemed to be no other manner to overcome it, but for countries to instigate lockdowns that brought their economies to a standstill. Thereby the result has been the worst recession since the Great

Depression. Lives were overturned in numerous ways to deal with this crisis. The ensuing collapse of economies occurred at unimaginably rapid rates and magnitudes. Changes to people's lives everywhere have been profound: slowdowns of economies, loss of jobs, upheavals of climates, upsurge of technology, and automation resulting in job losses, upswing of digital currencies, depressed returns on savings, greater inequalities, and rising debts. Nonetheless, along with the usual global forces, this unexpected crisis holds promise of a new challenge and opportunity at building a brighter tomorrow for everyone. Good faith and shared goals constitute the means for solutions even when the problems are unusually pressing. The expected recovery then can mean a global economy that serves all [153].

The housing sector has suffered numerous difficulties from the pandemic, including in the field of green buildings. The sector's problems are not limited to the present but will continue for some time. Problems include renting during the COVID-19 surge. Responses to pandemic policies require attention, and these need to be understood in terms of their impacts. Other topics involve coordinating policies in light of housing outcomes during the COVID-19 outbreak. Then, following the pandemic, consideration must be made of relationships between landlords and renters and of the entire concept of green buildings. Lockdowns have already lasted over 10 months. Thus people were forced to sleep, eat, work, work-out, and socialize, all at home. This leads to one conclusion—larger living spaces that overlook green areas need to constitute the focus of green housing design strategies.

The COVID-19 pandemic has added a great deal of uncertainty to many areas of human life—at work, at home, in leisure time. For many people, their homes are now the only place where they work and spend free time. A look at various aspects of housing through the lens of the pandemic is, therefore, very important. The question is whether the drive to protect human health will become the key point in the analysis of housing priorities, with a focus on the quality of indoor environment, the choice of building materials, and expected changes in sustainable design requirements for residential buildings. Finally, a rethinking of sustainability requirements for residential buildings is one challenge of this pandemic. Future building assessment will likely focus more on its occupants than the building itself. More waves of the COVID-19 outbreak are possible and to mitigate its influence, its impacts must be analyzed.

Currently many countries face many challenges and needs for housing improvements requiring solutions. Micro-, mezzo-, and macro-environments in housing pertinent to COVID-19 involve numerous aspects. Working from home is on an upswing; thus, suitable environments must be enabled. COVID-19 is bound to cause new requirements for future homes. These will involve resource efficiency throughout a building's lifecycle, larger lots as well as smart bathrooms and bidets. There will be new aspects to multi-generational homes, which will now require unique spaces, such as, e.g., more rooms and more bathrooms. Future homes cannot be simply smart homes—they must be healthy and energy-efficient homes. Floor plans will require more open spaces. Creative locales within the home can be designed for office use. Management teams will be designated for infrastructural facilities and different, smaller teams for technical facilities. Daily hygienic needs must be on-site in simplified designs. Checklists must be generated for daily health and safety needs. Building Information Modelling (BIM) and other digital means need to fight with COVID 19, e.g., by digital risk monitoring on construction sites and in work sites. Relevant systems would include data analysis, alerting, video surveillance, Internet of things (IoT), and non-invasive temperature monitoring. Plans should include reporting on health on a daily basis and the ability to diagnose remotely. Proptech would change facilities management on a step-by-step basis by employing workplace wellbeing, efficient energy consumption, optimal use of available space, and data management.

The literature under review originated only in part of the countries the pandemic has affected. Therefore the studies reviewed do not include all the areas around the world that have been infected by this virus. Hence, the affected countries with extremely vulnerable populations still call for adequate coverage. Nonetheless, there is a considerable overview of proposed policies aimed at the pandemic, so the green housing research community and its overall sector has been considered in light of the main, pertinent guidelines.

Aspects of green housing in the era during and post COVID-19, green housing trends and its interrelations are presented in the Figure 2.1. These factors are briefly analyzed below.

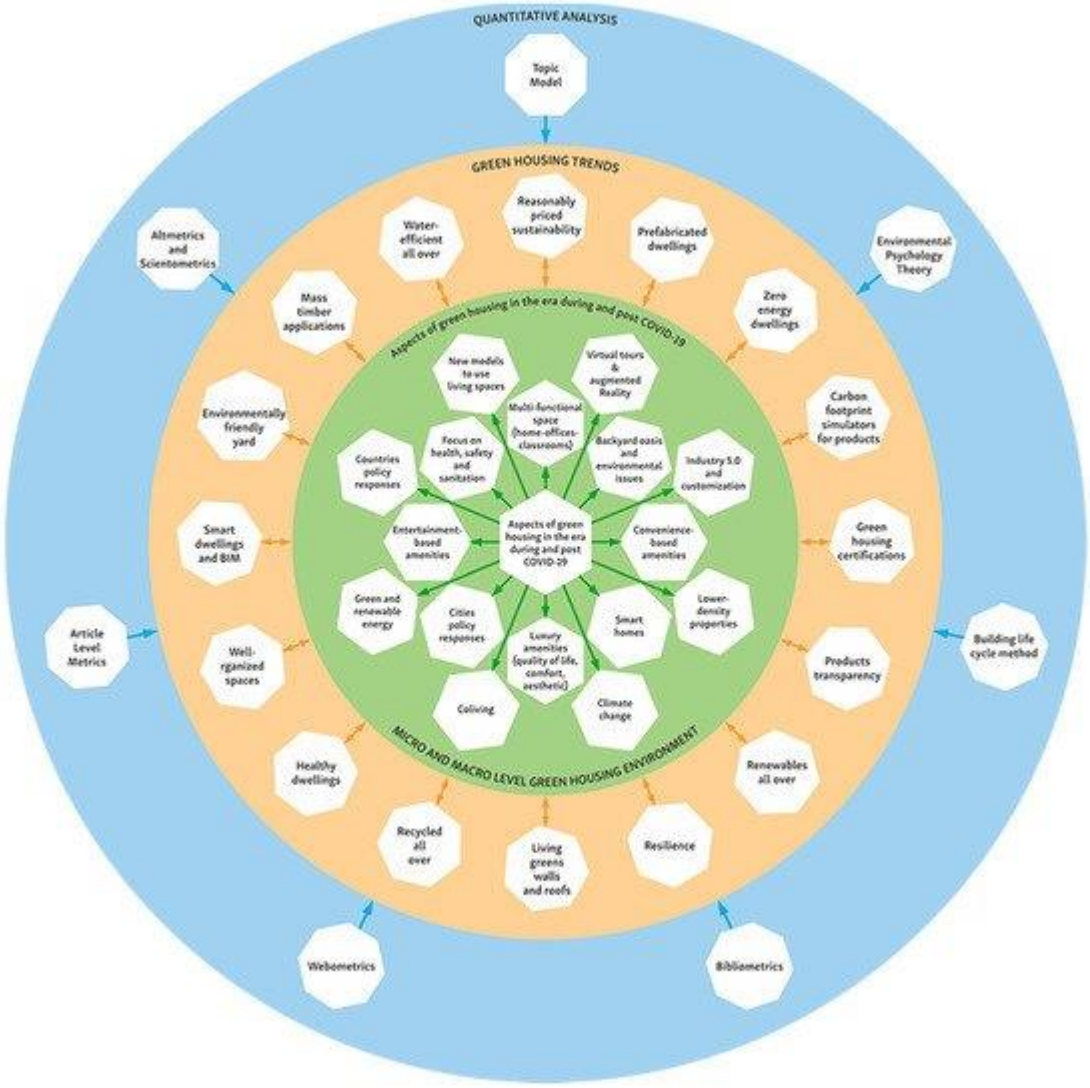



**Figure 2.1.** Green housing quantitative and qualitative aspects during and after the COVID-19 pandemic. A quantitative analysis on green housing is possible by applying the Topic Model, Environmental Psychology Theory, building life cycle method and certain elements of Bibliometrics, Webometrics, Article Level Metrics, Altmetrics, and Scientometrics. These methods are briefly described next.

"How can the development of ideas in a scientific field be studied over time?" This was the question that Hall et al. [154] attempted to answer by studying the history of ideas using topic models. An analysis of the historical developments in Computational Linguistics field from 1978 to 2006 was also undertaken by Hall et al. [154] by applying unsupervised topic modelling to the Anthology of Computational Linguistics (ACL). Their study involved inducing topic clusters by applying Latent Dirichlet Allocation for investigating the strength of every topic over time. The methods employed by Hall et al. [154] discover developments in this field. These included the rise of probabilistic methods from their beginning in 1988, a stable growth of pertinent applications and a pronounced drop of research in semantics and understanding between 1978 and 2001, which showed some growth only after 2001.

Rosen-Zvi et al. [155] provide the author–topic model for modelling topics pertinent to document authors, meant to upgrade topic detection in documents with authorship information. Topic modelling on abstracts from the Proceedings of the National Academy of Science (PNAS) was applied by Griffiths and Steyvers [156] to identify topics with growing or falling popularity from 1991 to 2001. A topic model

for geographically distributed documents was developed by Yin et al., 2011 [157]. Here latent regions detected by inference, which explain document positions. Newman and Block [158] determined the temporal dynamics of topics from 1728 to 1800 in the Pennsylvania Gazette, which constituted an approach for temporal information. Network information between linked documents in the relational topic model were included by Chang et al. [159] for the purpose of modelling such links between websites. Meanwhile Lamba and Madhusushan (2019) [160] were applying topic modelling on full-text research articles that they took from the DESIDOC Journal of Library and Information Technology (DJLIT) from 1981 to 2018.

Webometrics is the term Almind and Ingwersen [161] applied to reference quantitative studies of the web. A definition of webometrics was provided by Björneborn and Ingwersen [162]. They claimed it is the study of bibliometric and informetric approaches, which serve as a source for the quantitative aspects of the construction and use of information resources, structures, and technologies on the Web.

Bibliometrics refers to the analysis of scientific publications by applying a set of quantitative methods. A bibliometric study involves quantifiable forms of a publication or any aspect of that publication, such as its number of words, the time delayed after its submission until its publication and other similar aspects. Bibliometric measures that appear most often are the following [163]:

- The productivity of some certain researcher or research group measured by the number of respective publications issued.
- The number of citations from a publication appearing in later publications written by other scholars to indicate the interest generated by that respective publication.
- The number of downloads of an electronically available publication by readers to indicate its importance.
- The number of times on average that articles published in certain journals are cited within a certain time period following publication to indicate of the scientific importance of that journal or how comprehensive its peer review is.

How the scientific community handles a particular piece of research constitutes its scientific impact. Thus the interest the scientific community pays to some certain article in a professional journal after publication is a matter undertaken by Article Level Metrics (ALMs) by a wide range of metrics. Such metrics can include citations, usage statistics, discussions regarding online comments and social media and social bookmarking as well as different recommendations [164]. Lin and Fenner [164] covers why Article Level Metrics constitute an important extension of traditional citation-based journal metrics as well as presents several examples. A variety of metrics, e.g., have been accumulated and displayed by Public Library of Science (PLOS) since 2009 for every one of its articles. Furthermore PLOS also collects metrics about how many times an article has been saved in online reference managers like Mendeley in addition to its statistics on the frequency a certain article has been viewed and downloaded, meaning the statistics on its citations and usage. Other metrics included by PLOS regard the frequency of discussions about an article in its online comments, in science blogs and/or in the social media. In addition to these metrics, PLOS also notes the frequency of recommendations of a certain article by other scholars. A consideration of citations alone would exclude all the other valuable information, which these added metrics provide [164].

The “impact” or “reach” of some, one article is referenced as Article Level Metrics (ALMs), referencing an entire range of measures offering such insights. Citations at the journal level are measured by the well-known Impact Factor. Meanwhile the research impact of an article is measured by ALMs aiming for transparency and thoroughness. ALMs view citations and their usage and, additionally, present the coverage of an article along with discussions that appear on the social web [165]. The discussions regarding an individual article along with its sharing and use comprise a picture that Article Level Metrics (ALMs) present. The effort of ALMs involves measuring impact at the level of a single article. To accomplish such a measure, some traditional data sources like times cited are used by ALMs as well as certain new sources like tweets. The definition of altmetrics specifically references such an effort to include new data

sources for measuring impact brought about by either an article, a journal or even by some certain scholar. Data sources are the heart of altmetrics, not some level of aggregation. ALMs specifically define the impact of some, certain article by merging altmetrics with traditional data points [166].

A different group of metrics has appeared recently, over the past few years. This group, which has evolved to becoming a topic of interest and research in scientometrics, is now known as alternative metrics or altmetrics. It obviously differs from classical bibliometrics, as its name indicates, since it offers an alternative to citation analysis [167]. In Lin and Fenner [164] opinion, altmetrics used a very wide-ranging collection of metrics, such as citation of papers, papers views and downloads, recommended, science blogs, journal comments, discussed in Twitter, Wikipedia, or Facebook. Altmetrics is especially well defined by Priem et al. [168], who describe what it involves and how it can be used in addition to pinpointing the subjects of its focus. That different alternative metrics could be correlated with numerous traditional metrics, including, e.g., citations, was proposed by Priem et al. [168], or, alternatively, expert opinions might undertake an analysis of such a correlation.

The scientific measurement of work of scholars involving the means of analysis of their publications along with the citations within those articles is known as scientometrics (Wiktionary). The measure and analysis of science is a science called Scientometrics. Its practice frequently involves the use of bibliometrics or measuring the impact of publications (Freebase). Scientometrics is an instrument of the Sociology of Science, which is a sub-discipline dealing with quantitative evaluations of scientific activity that documents the sectoral economy of the scientific optical discipline, as per Vega-Muñoz and Arjona-Fuentes [169]. Furthermore these scholars proclaim that its application can also extend to the sub-discipline covering the sector of economics research and development.

In order to design and implement an effective green building life cycle process, it is necessary to analyze comprehensively its constituent parts, the participating in it interested groups as well as to consider external micro- and macro environment impact. In green building life cycle process stages, alternative variants are formed by changing a construction site, by rating possible green building volumetric-planned and other solutions, construction, and maintenance processes, etc. Variability of solutions helps to consider more rationally the present COVID-19 situation, external micro- and macro environment level factors, to make the project cheaper; to satisfy better architectural, aesthetic, comfort and other requirements of the client as well as aims of all participating in the project interested groups (see Figure 2.1).

How can effective green building life cycle process be determined, if different interested groups participate in it, there can be hundreds of thousands of alternative projects variants, when, with the change of constituent parts of green building life cycle process, COVID-19 situation, external environment, the effectiveness of the entire project also changes? In addition, the implementation of some aims can be more rational economically than others; however, they are differently significant from other aspects. Thus, it is considered that the effectiveness of green building life cycle process depends on the rationality of its constituent parts, the level of interested groups goals achievement and the rationality of the external environment. This analysis formally describes how with the change of constituent parts of the project, COVID-19 situation, external environment, the level of different goals achievement, and the level and price of green building life cycle process effectiveness change.

The research's object consists of green building life cycle process, the participating in it, and willingness to implement its interested group's goals, COVID-19 situation, and external micro- and macro level environment as a whole. Green Housing Topic Model was developed in order to perform a detailed analysis of this analysis object.

The objective of research is the increase of green building life cycle process effectiveness by applying a newly developed Green Housing Topic Model.

It has not been analyzed in detail till now how COVID-19, housing COVID-19 policies of countries and cities impact green housing and the wellbeing of residents, and also the residents and a housing policy impact the dispersion of COVID-19. A green building analysis is also much more effective in a

comprehensive analysis of green building life cycle process, the participating in it interested groups, willing to implement their goals, COVID-19 situation, external micro-, and macro level environment as a whole. Due to these two reasons, the research was undertaken in order to fulfil the gap in the knowledge of the green housing before, during, and post COVID-19.

## 2.1. METHODOLOGY

An integrated quantitative analysis on green housing before, during, and after COVID-19 is possible by applying the Topic Model, Environmental Psychology Theory, building life cycle method, and certain elements of Bibliometrics, Webometrics, Article Level Metrics, Altmetrics, and Scientometrics. These methods were described in brief in the Introduction.

Development of the Green Housing Topic Model took place during the course of the research when the worldwide scientific literature was under analysis and the statistical analysis was taking place of appropriate articles from different bibliographic databases. The development of the Green Housing Topic Model occurred in seven stages:

1. Search
2. Compilation of a two-dimensional green building map
3. Comparison of articles published in 2019 and 2020 on green buildings by specific key search words
4. Raising a hypothesis (Hypothesis 1) on the correlation and distribution of topic words
   **Hypothesis 1.**
   *On the correlation and distribution of topic words*.
5. Compilation of a colored document-frequency matrix
6. Raising and validating the two hypotheses (Hypotheses 2 and 3) and the interlink between them
7. Establishment of green housing trends on a micro and macro scope
8. Brief descriptions of these stages follow.

In the first stage of the Model, we performed a scientific literature search SCOPUS and Web of Science databases. We also analyzed the publications of American Planning Association and American Society of Civil Engineers peer-reviewed journals and the announced publications of Organization for Economic Co-operation and Development. Databases were searched by using a combination of various keywords and the criteria for paper selection including green building, sustainable building, green construction, resource-efficient, a building's lifecycle, COVID-19, energy, water, consumption, health effects, comfort, occupant behaviors, policy, economy, Industry 5.0, energy-efficient retrofitting, and profit. Searches were limited to research published from 1974 up to the date of the search (5 March 2021).

For example, 3477 green building articles were publicized in a Web of Science Core Collection database from 1999 to 2021. The following papers were announced in Web of Science Categories: construction building technology (952), engineering civil (776), environmental sciences (607), architecture (311), environmental studies (298), urban studies (167), regional urban planning (111), public environmental occupational health (63), business (57), computer science artificial intelligence (57), etc. Web of Science Core Collection database green building Hi = 81, average citations per item is 10.33, the sum of times cited is 35,906 (without self-citations—27,692), citing articles are 21,089 (without self-citations—19,600). In the analyzed period, in total 1877 articles, 1384 proceedings papers, 162 reviews, 41 editorial material, etc., were printed on green building topic.

Figure 2.2 displays a two-dimensional green building map. Its basis constitutes the data from the search SCOPUS database from the second stage of the model. This figure indicates topic similarities as per the manner of their distribution over keywords. The topic label additionally indicates how to best capture the semantics of the top keywords. Figure 2.2 presents the keywords taken from the search on green buildings in 2019 in a circle. These reflect the following on a green building:

- a life cycle along with the latest information, artificial intelligence and other technologies applied to it (a)

- level of user satisfaction with green buildings and resources and aspects of green matters, environmental protectors, and renewables (b)
- national, city wide, residential area and decision-making dimensions (c)
- green building aspects (d).

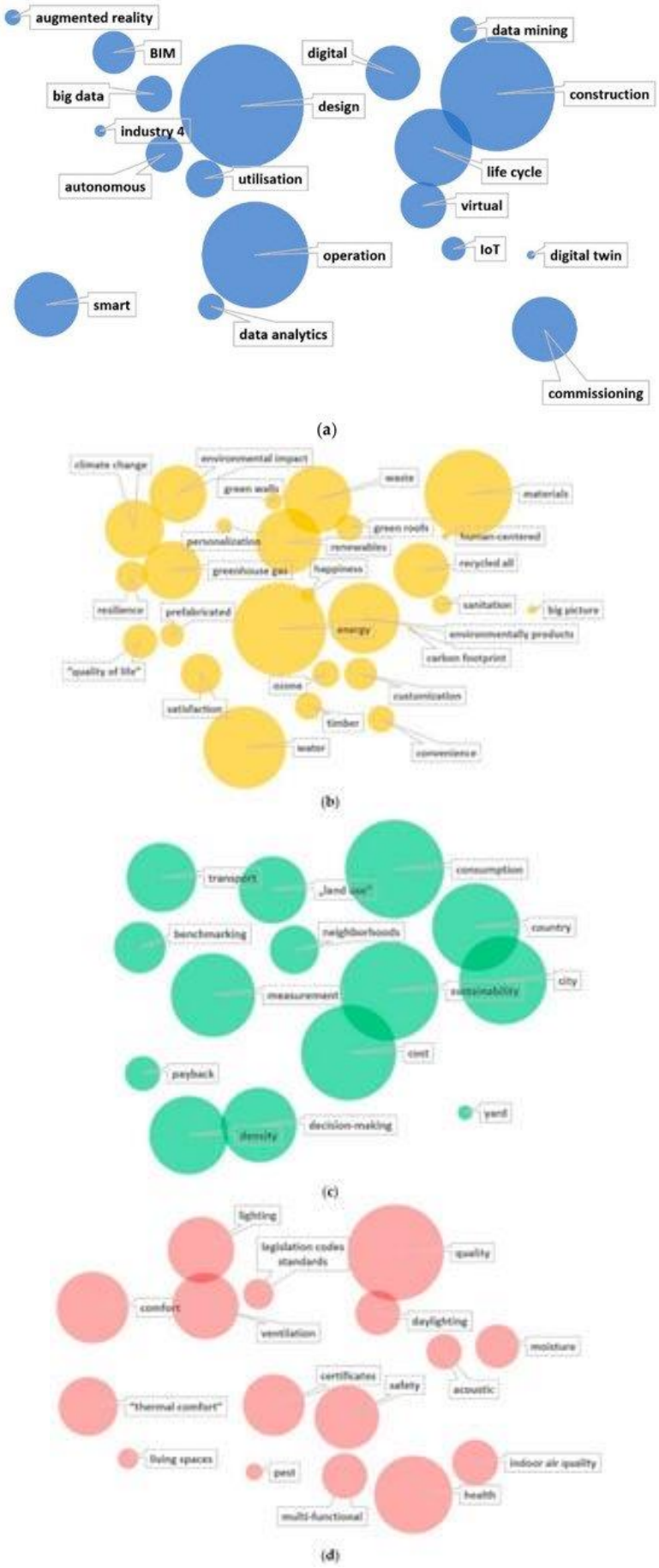
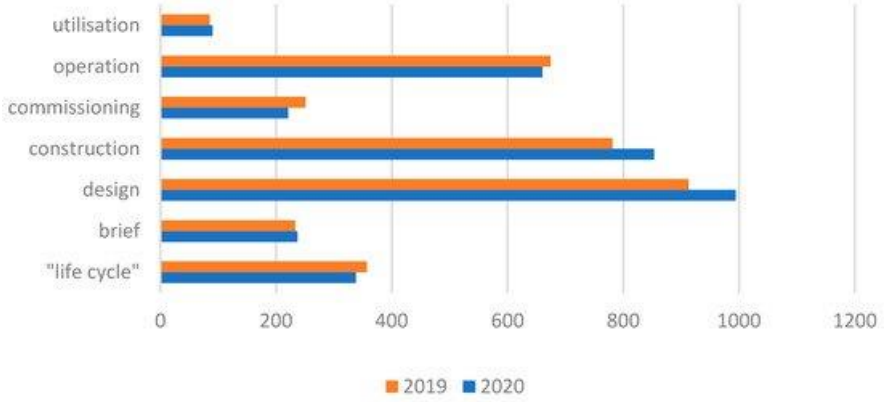



**Figure 2.2.** Two-dimensional green building map with circles in sizes indicative of the number of articles published in the Scopus journal database in 2019 according to specific key search words on green

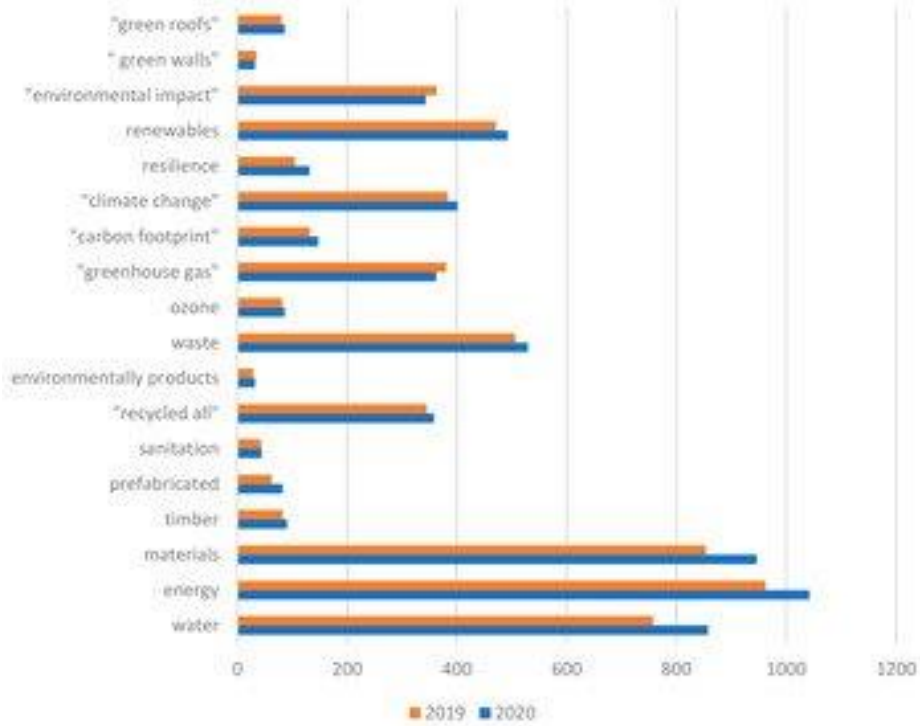
buildings. A life cycle along with the latest information, artificial intelligence and other technologies applied to green building (a); level of user satisfaction with green buildings (b); national, city wide, residential area and decision-making dimensions (c); green building aspects (d):

Figure 2.2 submits circles in sizes indicative of the number of articles issued in ScienceDirect journals in 2019 according to the key search words for specific green buildings.

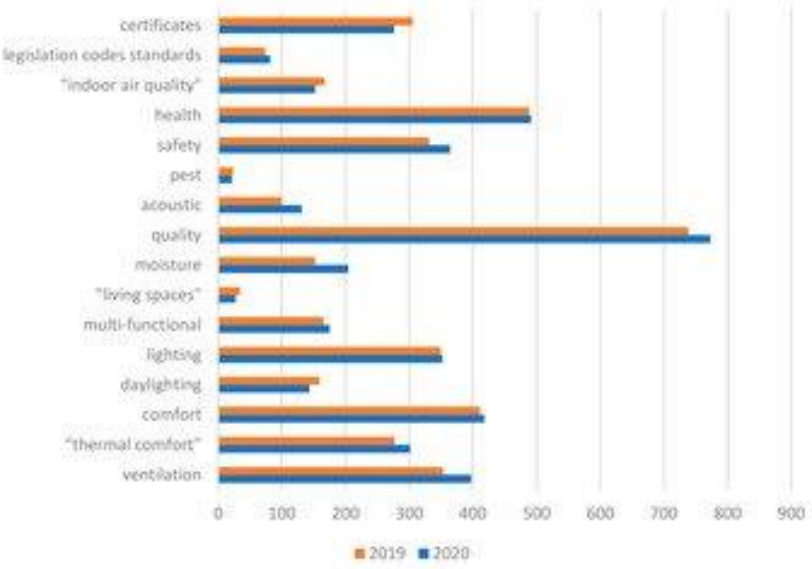
Comparisons of articles published in 2019 and 2020 in the Scopus journal database according to specific key search words for green building during the Third stage of the model. Figure 2.3 shows the y axis containing the numbers of articles found in the Scopus journal database by year according to specific key words. For example, in 2020, there were 853 articles in the Scopus journal database published according to the key words “green building” and “construction”, whereas, in 2019, there were 781 such articles. The overall number of articles in the 2020 database under analysis increased by 8.5 percent when compared with the 2019 database. Meanwhile, during this same period, the number of articles on green housing increased by 10.5 percent.




(a)




(b)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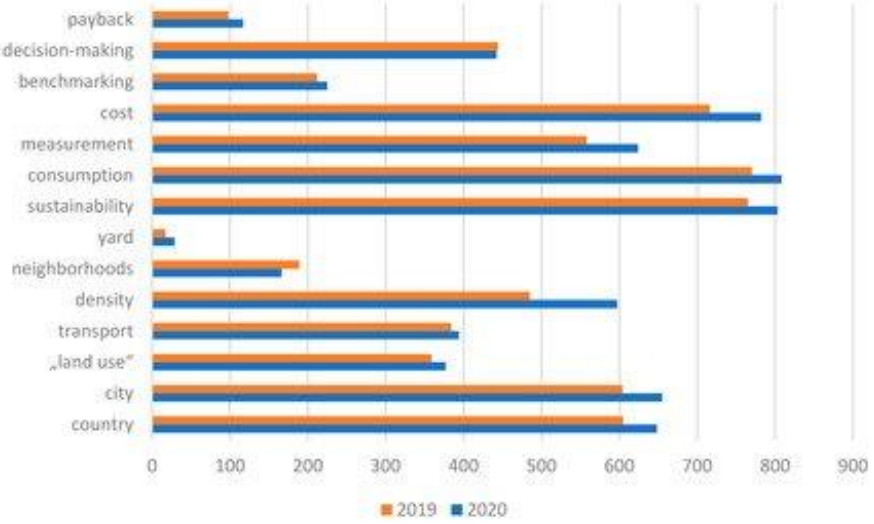
(c)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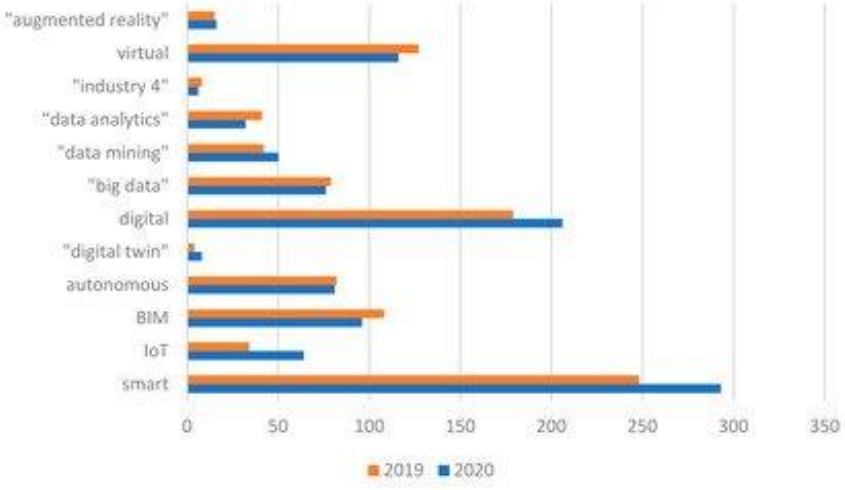
(d)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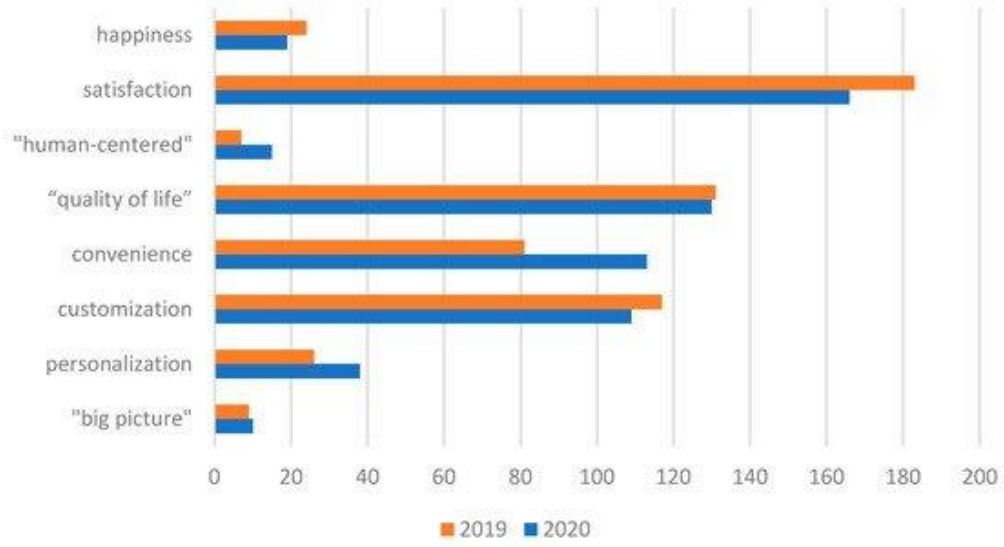
2020

(e)




(f)

**Figure 2.3.** Comparison of articles published in the 2019 and 2020 Scopus journal databases by key words reflecting (a) Green building life cycle, (b) Resources, green matters, environmental protectors, renewables, and climate change aspects, (c) Green building aspects, (d) National, city-wide, residential area and decision-making dimensions, (e) Applications of latest information, artificial intelligence, and other technologies and (f) Level of user satisfaction with green buildings.

The correlation and distributional hypothesis of topic words was raised and substantiated during the Fourth stage. A qualitative approach to automatically uncover the coherence of a topic are, as proposed by researchers in the field, topic coherence measures [170,171]. Meanwhile the root of the underlying idea lies in the distributional hypothesis of linguistics [172]. Additionally words with similar meanings tend to occur in similar contexts. Whenever all or most words relate with one another, e.g., the leading N words of a topic, then the topics are considered coherent [159]. The distributional hypothesis was also raised during the course of this research that the key words relevant to the green building topic strongly correlate with one another (see Table 1.3).

**Table 1.3.** Strong correlation coefficients obtained between user satisfaction with green buildings, the life cycle of a green building and the national, city-wide, residential area, and decision-making dimensions.

| | Country | City | "Land Use" | Sustainability | "Quality of Life" | "Human-Centered" | Satisfaction | Happiness | "Life Cycle" | Brief | Design | Transport | Density | Neighborhoods | Yard |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| country | 1 | 0.995 | 0.995 | 0.996 | 0.992 | 0.776 | 0.991 | 0.853 | 0.989 | 0.994 | 0.997 | 0.997 | 0.991 | 0.987 | 0.899 |
| city | - | −1 | 0.995 | 0.995 | 0.989 | 0.774 | 0.984 | 0.856 | 0.980 | 0.988 | 0.996 | 0.997 | 0.994 | 0.986 | 0.880 |
| "land use" | - | - | 1 | 0.996 | 0.991 | 0.777 | 0.983 | 0.833 | 0.986 | 0.987 | 0.994 | 0.996 | 0.984 | 0.988 | 0.902 |
| sustainability | - | - | - | 1 | 0.985 | 0.726 | 0.986 | 0.827 | 0.993 | 0.987 | 0.998 | 0.995 | 0.986 | 0.984 | 0.900 |
| "quality of life" | - | - | - | - | 1 | 0.781 | 0.979 | 0.871 | 0.972 | 0.988 | 0.984 | 0.989 | 0.980 | 0.986 | 0.888 |
| "human-centered" | - | - | - | - | - | 1 | 0.759 | 0.710 | 0.694 | 0.790 | 0.751 | 0.778 | 0.823 | 0.749 | 0.618 |
| satisfaction | - | - | - | - | - | - | 1 | 0.866 | 0.990 | 0.993 | 0.990 | 0.992 | 0.984 | 0.991 | 0.859 |
| happiness | - | - | - | - | - | - | - | 1 | 0.804 | 0.875 | 0.829 | 0.854 | 0.862 | 0.872 | 0.676 |
| "life cycle" | - | - | - | - | - | - | - | - | 1 | 0.985 | 0.993 | 0.988 | 0.974 | 0.980 | 0.891 |
| brief | - | - | - | - | - | - | - | - | - | 1 | 0.991 | 0.994 | 0.986 | 0.990 | 0.877 |
| design | - | - | - | - | - | - | - | - | - | - | 1 | 0.997 | 0.991 | 0.985 | 0.893 |
| transport | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.991 | 0.991 | 0.885 |
| density | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.977 | 0.873 |
| neighborhoods | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.861 |
| yard | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |

Table 1.3 shows a matrix in which the obtained correlation coefficients were strong between user satisfaction with green buildings, the life cycle of a green building and the national, city-wide, residential area and decision-making dimensions (see Table 1.3). Analogically strong correlations were also obtained between other key search words. These strong correlations indicate that the key search words were appropriately selected for performing the analysis on green housing before, during, and after the COVID-19 Big Picture analysis. The distributional hypothesis was also confirmed during the progression of this study that the key words pertinent to the green building topic strongly correlate with one another.

The Fifth stage involves compiling a colored, document-frequency matrix. The columns of the colored, document-frequency matrix presented in Table 1.4 contain key words reflecting user satisfaction with green buildings and the life cycle of a green building. The rows of Table 1.4 contain the number of articles found in the Scopus journal database by year according to specific key words. For example, in 2020, there were 130 articles published in the Scopus journal database containing the key words “green building” and “quality of life”, whereas, in 2009, there were 24 such articles. These numbers appear within the colored cells of the matrix by which the darkness of the color demonstrates the number of published articles, the darker the color, the greater the number of published articles.

**Table 1.4.** Key words reflecting user satisfaction with green buildings and the life cycle of a green building as well as colored cells in which the darkness of the color demonstrates the number of published articles (the darker the color, the greater the number of published articles).

| Year | “Big Picture” | Personalization | Customization | Convenience | “Quality of Life” | “Human-Centered” | Satisfaction | Happiness | “Life Cycle” | Brief | Design | Construction | Commissioning | Operation | Utilization |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | 10 | 38 | 109 | 113 | 130 | 15 | 166 | 19 | 338 | 237 | 994 | 853 | 221 | 660 | 90 |
| 2019 | 9 | 26 | 117 | 81 | 131 | 7 | 183 | 24 | 357 | 233 | 913 | 781 | 251 | 674 | 85 |
| 2018 | 5 | 33 | 99 | 60 | 108 | 14 | 162 | 15 | 353 | 211 | 847 | 716 | 257 | 567 | 78 |
| 2017 | 13 | 21 | 94 | 66 | 102 | 4 | 148 | 7 | 385 | 191 | 909 | 783 | 253 | 612 | 71 |
| 2016 | 5 | 18 | 74 | 54 | 97 | 5 | 119 | 14 | 295 | 180 | 718 | 651 | 205 | 481 | 49 |
| 2015 | 2 | 14 | 53 | 50 | 70 | 3 | 103 | 9 | 257 | 128 | 614 | 523 | 178 | 394 | 49 |
| 2014 | 3 | 9 | 49 | 38 | 65 | 3 | 74 | 8 | 197 | 108 | 467 | 385 | 147 | 327 | 44 |
| 2013 | 6 | 12 | 32 | 30 | 48 | 2 | 52 | 7 | 115 | 86 | 302 | 267 | 118 | 218 | 37 |
| 2012 | 5 | 2 | 36 | 30 | 64 | - | 59 | 3 | 128 | 92 | 330 | 278 | 122 | 211 | 32 |
| 2011 | 4 | 8 | 21 | 21 | 57 | 3 | 38 | 8 | 102 | 65 | 341 | 309 | 94 | 199 | 21 |
| 2010 | 4 | 3 | 31 | 24 | 35 | 2 | 44 | 9 | 97 | 63 | 211 | 184 | 99 | 159 | 10 |
| 2009 | 1 | - | 10 | 15 | 24 | 1 | 14 | 1 | 47 | 28 | 108 | 95 | 41 | 77 | 11 |
| 2008 | 1 | 3 | 16 | 5 | 18 | - | 24 | 3 | 56 | 51 | 132 | 109 | 57 | 84 | 15 |
| 2007 | - | 3 | 9 | 5 | 10 | - | 6 | 3 | 26 | 28 | 80 | 57 | 33 | 48 | 8 |
| 2006 | 1 | 1 | 6 | 5 | 9 | - | 18 | 2 | 55 | 25 | 113 | 87 | 45 | 70 | 1 |
| 2005 | 1 | - | 2 | 6 | 6 | - | 6 | - | 24 | 11 | 46 | 32 | 13 | 21 | 2 |
| 2004 | 1 | - | 1 | 1 | 4 | - | 3 | - | 7 | 6 | 26 | 22 | 11 | 11 | 1 |
| 2003 | - | 1 | 1 | 1 | 2 | - | 2 | - | 3 | 9 | 22 | 17 | 10 | 12 | 1 |
| 2002 | - | 1 | 1 | 1 | 4 | - | 1 | - | 6 | 3 | 23 | 22 | 7 | 10 | 5 |
| 2001 | - | - | 1 | 1 | 2 | - | 3 | - | 6 | 2 | 14 | 11 | 3 | 6 | - |
| 2000 | - | - | 1 | - | 1 | - | - | - | 6 | 4 | 12 | 12 | 3 | 7 | 3 |
| 1999 | - | - | 2 | 1 | 2 | - | 1 | - | 3 | 1 | 7 | 7 | 2 | 5 | 1 |
| 1998 | - | - | 1 | - | - | - | 1 | - | 1 | - | 5 | 4 | 1 | 2 | - |

The interlink between green housing and COVID-19 was methodically studied during the Sixth stage of the model to test the hypothesis regarding the interactions between COVID-19, the housing COVID-19 policies of relevant countries and cities and the behaviors of their residents along with their demands for green housing. Two hypotheses were raised during the Sixth stage:

- **Hypothesis 2.**

*COVID-19, housing policies of countries and cities during COVID-19 impact green housing, and the wellbeing of their residents; additionally the residents and a housing policy impact the dispersion of COVID-19*.

- **Hypothesis 3.**

*A green building analysis is markedly more effective, when the life process of a green building along with the interest groups participating in it with goals they wish to implement of their own, the COVID-19 situation and the external micro- and macro-level environments are comprehensively analyzed as a single entity*.

The validations of these hypotheses were performed by analyzing the scientific literature worldwide and a statistical analysis of appropriate articles in the Elsevier ScienceDirect bibliographic database. The scholars of this research integrated research design enrichments to derive greater reliability of the hypothetical relationship between COVID-19, the housing policies of pertinent countries and cities, and how their residents behave pertinent to their green housing demands.

The numeric data obtained pertinent to the presented conclusions were made based on the Green Housing Topic Model.

## 2.2. SUSTAINABLE HOUSING

### 2.2.1. Changes in the Way of People and Communities Live, Interact, and Work, and the COVID-19 Pandemic

The number of publications about COVID-19 on Web of Science (WoS) has been growing this year and more than 6000 references are now available, as it has on ScienceDirect where more than 8000 references can be found, but, in both cases, less than 1% of them deal with buildings or the built environment. A more focused research, however, shows that various journals published articles dedicated to the built environment in the context of the COVID-19 pandemic, analyzing potential preventive measures or discussing this issue through the lens of sustainable development [173]. However, from another viewpoint, every service unit has needed greater consumption of energy, water, and cleaning products due to the reduced capacities of outside services, e.g., the schools, shops, and restaurants that have ceased being users [173].

Lockdowns have changed the way people and communities live, interact, and work, and the COVID-19 pandemic reminds us the necessity to make the built environment resilient, including outdoor spaces, but especially homes, offices, entertainment facilities, public buildings, and other indoor spaces. How can the concept of public health and well-being be adjusted to the context of a future with evolving and transformed living places? Learning from this period of physical distancing, this research integrates wellbeing and hygiene in buildings, highlighting possible responses both for new and existing buildings. The following key categories of public health and wellbeing recommendations for sustainable, safe, and healthy housing have been selected: water consumption and wastewater management; solid waste management in cities; sharing, adaptability, and flexibility of living spaces, ensuring enough space per person, and adding compliant functions to buildings; reclamation of the basic archetypes and principles related to indoor air quality, thermal comfort, and sustainable architecture; visible and accessible green spaces and elements; electromagnetic fields and housing automation; building and décor materials and products for interior design. The recommendations from the aforementioned categories can serve as a basis for local health agencies, public health experts, policy makers (tax incentives tied to building refurbishment), and designers in speaking up for policies and actions aimed at promoting and maintaining physical and mental wellbeing in healthier living places [174].

The spread of SARS-CoV-2 with its extended lockdowns, school and university lectures moving online, and millions of people forced to turn to teleworking and spend most of their time at home has changed the way of life in home spaces. The pandemic has also made an impact on real estate values, with some characteristics becoming more desirable, while others falling out of favor. A group of university researchers present their ideas in this brief study. They are experts in public health and architecture-

related health issues and have been addressing the health problems related to modern urban life and homes for many years. This aim could promote closer and broader scientific links between medicine and architecture to improve the wellbeing of people in any environment, with emphasis on urban settings [175].

When, on 11 March 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a pandemic, the Italian Government imposed severe lockdowns with extremely restricted movement. As people were forced to stay indoors, all their life happened at home where they ate, slept, exercised, worked, socialized, and engaged in other activities. Evidence shows that housing is a significant determinant of health. The lockdown measures related to COVID-19 response and their impact on mental health and wellbeing are, therefore, an interesting area to explore. In Europe, Northern Italy has been one of the most affected regions by the pandemic, and the authors of this study carried out a large online survey of 8177 students from a university institute in Milan. Our analysis shows a link between poor housing and higher risk of lockdown-related depressive symptoms. Among surveyed people, those reporting a drop in performance when they work from home were more than four times more likely to report depression as well. Housing design strategies should focus on larger and more livable living spaces facing green areas. Authors argue that a stronger multi-interdisciplinary approach is needed to investigate the ways the built environment can affect mental health. Such approach, where sociology, epidemiology, public mental health, environmental health, and urban planning intertwine, would benefit decision making and inform housing and welfare policies aimed at ensuring the wellbeing of people [176].

The COVID-19 pandemic has changed many aspects of our life and is offering an opportunity to change the way we design our living spaces. A comfortable and healthy home is an important contributor to mental and physical wellbeing. Based on the latest documents, including peer-reviewed papers, news, media articles, blog posts, and expert opinions, this study presents a critical review of COVID-19-related lessons and looks at changes in the sustainability requirements for residential buildings that can be expected. Lockdowns tested the three main aspects of residential buildings, i.e., comfort, environment, and health and safety. A major overhaul of these aspects towards sustainability is expected. Proper sanitation to diminish the probability of getting infected, new touchless technologies, and greener and more intimate spaces for better mental health are just a few solutions that can improve health and safety protection in our homes. The lockdowns have resulted in much greater consumption of household energy globally due to the increased time people spend at home. One example is the 30% increase in energy consumption during the daytime, as per U.K. statistics. These sorts of spikes in use had occurred during mornings previously, when people would be getting ready to go to work. U.S. statistics show an overall increase in household electricity use of up to 8% during lockdowns. Another key topic during the pandemic is waste management because waste must be kept apart to prevent virus transmissions, since viruses can survive for 3–4 days on different surfaces [177].

It is widely accepted that health and housing are related. In Victorian England, for instance, people hypothesized links between poor housing and ill health and were looking for solutions; indeed, better sanitation and slum clearance did much to improve health. Soon many countries followed suit, Italy among them. A growing body of knowledge about infectious diseases and illnesses made people more aware that the quality of housing is an important factor for physical and mental wellbeing. This has been recently reaffirmed by the WHO and vividly reminded by the COVID-19 pandemic. The built environment, and in particular housing, where people spend lots of time, is a significant source of indoor pollutants, especially in bad-quality housing generally occupied by very low income households. WHO 2011 estimates attribute 13 deaths per 100,000 inhabitants to low indoor temperatures, 2–3 to radon, and 7 to environmental tobacco smoke (ETS) per year globally. In terms of disability-adjusted life years (DALYs), 40 DALYs per 100,000 children are annually lost due to mold in homes, 577 DALYs per 100,000 children younger than five are caused by solid fuels as an energy source in homes, 31 DALYs per 100,000 inhabitants are lost each year due to traffic noise exposure, and 22 DALYs per 100,000 inhabitants due to

lack of home safety features. The use of solid fuels in homes is also responsible for 17 deaths per 100,000 children [178].

COVID-19 lockdowns attended by economic shutdown and social isolation have disrupted individual lifestyles and society's priorities with serious sustainability implications. Grounded planes, as well as lower vehicle traffic flows and industrial activity reduced society's ecological footprint, as homebound families turned to non-commercialized leisure modes and social interactions. However, social isolation has hit mental and physical health, and economic recession has also caused adverse effects exacerbating issues of underconsumption and poverty [179]. The pandemic, as some sustainability researchers believe, could potentially speed up the progress towards a future of more social fairness and better environment protection [179,180]. We have been given a rare opportunity for putting together a sustainable transition towards broadly-adopted low-carbon solutions with both shifts in individual lifestyles and systemic-institutional reforms driven and implemented by multiple stakeholders [179,181]. The changes caused by COVID-19 are a source of both worry and hope for organizations engaged in the advancement of sustainable development. The source of hope have been palpable short-term environmental benefits such as pollution decreases [179,182] brought about by government measures. These events have demonstrated that policy makers can and have the will to introduce systemic changes away from an endless work-spend cycle and non-stop consumerism [160,183]. Unfortunately, counter-pandemic measures have also led to adverse effects with serious sustainability consequences: they have unsettled sustainable development goals reversing, for the first time in 30 years, the progress towards lower poverty and misery [179]; deprived millions of children of access to education; led to social isolation to the detriment of mental and physical health [179,184,185]; and undermined the efforts to make people less dependent on the use of plastics [8] and individualized modes of transport [186], among others.

Faced with the devastating COVID-19 pandemic, people were suddenly forced to change many aspects of their usual lifestyles—an unprecedented event. However, besides adverse effects, the COVID-19 pandemic can also push individuals towards environmental responsibility. The authors of this study provide a comprehensive analysis of shifts in pro-environmental beliefs and behavior catalyzed by the COVID-19 pandemic with a focus on the comparison between recycling and consumption reduction pre-COVID-19 with intentions post-COVID-19. The authors analyze a survey conducted during the national March–April 2020 lockdown imposed in Israel and validate the behavioral model using a generalized ordered probit estimated on a sample of 296 respondents. The findings show that shifts in behavior towards pro-environmental approach are driven by threat and coping appraisal [187].

To contain the spread of a new and unknown highly contagious virus with relatively high mortality rates, humanity seems to have no choice but to limit social contacts and put an emphasis on personal hygiene. The pandemic has hit a heavy blow to the world economy; the energy sector suffered as well. As people are forced to stay at home, energy and water consumption in the residential sector has gone up. Using EnergyPlus software packages (U.S. Department of Energy's (DOE) Building Technologies Office (BTO)), this study looks at a household in Kragujevac, Central Serbia, and analyzes four simulated scenarios for the month of March 2020 to discover correlations between the way people behave and the residential consumption of natural gas, electricity, and water in unforeseen circumstances, such as the COVID-19 pandemic. The behavior of people was tracked at a one-minute time step, taking into consideration the number of household members, their habits, occupation, age, lifestyle (in line with socio-economic and cultural circumstances), and the pandemic-related measures taken by the Government of Serbia. Energy consumption at the level of Kragujevac for the past three years has also been analyzed, based on the data available from public utility companies distributing natural gas, thermal energy, water, and electricity, as has the quality of air for the same time period, in view of its dependence on mobility and energy consumption patterns [188].

All areas of socio-economic life have been affected by the COVID-19 pandemic and the world has been changing rapidly in recent months with concerted efforts focused on ensuring public health, and then, in the next phase, looking for means to jumpstart economic recovery by resuming the human

activities. Adequate housing has proved to be an important means of ensuring the well-being and health of the population. At the same time, housing is a point of stability from which all efforts start. This research, based on data provided by the National Institute of Statistics, the Quality-of-Life Research Institute, Eurostat, and reports from specialized European organizations, aims to call attention to a number of housing affordability problems in the general picture of housing at the national level in Romania, looking at both the issues that existed before and new issues related to the COVID-19 pandemic. The role these issues play in access to affordable and adequate housing is analyzed, the emergence of new risk groups with limited access to housing discussed, the impact of the pandemic on the ability of households to pay their bills examined, and evidence that the effects of the crisis amplify housing insecurity provided [189].

### 2.2.2. Necessary Changes in Built Environment during the Pandemic towards Sustainable Living

The COVID-19 pandemic forced people to stay indoors and work from home, but even before this health crisis they spent around 90% of their time in buildings. We need a radically new take on the design and operation of buildings. When Indoor Environmental Quality (IEQ), which directly affects the well-being and comfort of occupants, is compromised, occupants become more exposed and vulnerable to many diseases that can be exacerbated by both economic and social factors. The estimated annual cost linked to sick building syndrome in commercial workplaces is between $10 billion and $70 billion in the United States alone. We need to understand ways we can ensure proper design of parameters that drive IEQ, as well as ways to operate buildings achieving ideal health-benefiting IEQ. IEQ offers many research opportunities, but now more than ever we need a systematic understanding of the way IEQ factors work for or against occupant health. Extreme events, a global pandemic among them, call to provide occupants, facility managers and designers with pragmatic guidance on ways to mitigate health risks in buildings. This research gives answers to ten questions related to the effects of buildings on occupant health and can serve as a basis for future work offering insights for new lines of research and discoveries [190].

In research on housing, one of important parts is looking at health-related aspects in indoor environment. This research presents an overview of the latest research on occupant health evaluation in residential buildings and examines some of the key impacts people experienced during the lockdowns. The authors analyze satisfaction and dissatisfaction across ten UK housing typologies, representative in this and other contexts. Lack of regular physical exercise, lack of vitamin D from sunlight, excessive food consumption, mental health, lack of good air circulation indoors, and issues with indoor air quality are the general health concerns in this extended period of lockdowns and restricted mobility. Excessive noise from upper floors in blocks of flats or from shared walls and gardens/communal spaces in closely-spaced residential areas, and issues of privacy to maintain social distancing measures are the other concerns discussed. Accessibility to the nearest outdoor spaces (a backyard or garden), noise and privacy issues, adequate indoor air circulation, adequate natural indoor lighting, opportunities to do physical exercises, and impacts on general health are evaluated. The earlier reports from various housing studies suggest that user satisfaction is important in indoor environments. As the COVID-19 pandemic hit, this field of research seems to have grown in importance as people are forced to spend long hours indoors and their thermal comfort and general comfort have to be maintained [191].

A year has already passed since the first cases of COVID-19 were detected and the novel SARS-COV-2 virus identified. The world has responded with a range of decisions. A few of the things we have learned from this complex COVID-19 crisis with interlinked political, social, public health, and economic dimensions, testing the world's ability to take measures, have a direct relevance to the climate crisis we are facing and our aims to achieve broader advances in sustainable development. First, the scientific community actively contributed to the handling of the COVID-19 pandemic and proved its ability to generate great quantities of new practical knowledge in a record short span of time. By 13 October, Pubmed, a database of research papers focusing on health sciences and biomedicine, offered over 63,000

hits for the search term “COVID-19” and the number of publications keeps growing. The number of search hits for “climate change” is, in contrast, only 53,000 papers since 1975—a sign of huge differences in scientific and societal priorities. However, faced with a sense of urgency, priorities and incentives can be aligned to push the scientific community towards producing new knowledge on climate change at the same pace and scale as in the case of COVID-19. Second, COVID-19 has shown that scientific research needs robustness even when we face an emergency. Hasty research of poor quality risks contributing more noise than actionable knowledge and can mislead public opinion or decision makers on vital issues; the Retraction Watch database has so far identified over 35 retracted COVID-19 publications. Third, COVID-19 has been a notable example of blurred lines between science and policy, at least in countries where leaders were keen to base their decisions and communication strategies on science, rather than disregard it. COVID-19 is striking not only because of the scale and pace of scientific production—the speed of putting new knowledge to action has also been impressive. Nonetheless, mere behavior changes among people during the COVID-19 period has been shown to be insufficient. Governments must engage in ambitious and sustained policies in their pursuits of structural emission reductions. One such example might be an acceleration pertinent to the development and deployment of cleaner energy [192].

The natural environment can suffer negative effects from construction activities and the concept of sustainability has, therefore, been introduced in the construction industry. The construction industry, according to the United Nations Environment Program, generates 33% of CO2 emissions, 25% of waste production, and 30% of all annual waste products. It is, therefore, important to ensure sustainability in residential buildings with an aim to reduce air pollution and greenhouse gas emissions and improve the quality of life and health outcomes. The drive towards sustainability in construction and buildings creates new jobs and business opportunities, boosts energy security, and productivity, and has also resulted in the promotion of assessment systems to increase sustainability, declarations to preserve the environment, and the development of various international policies [193].

Sustainability is an integrated part of construction processes and the building itself, and construction companies have a range of building sustainability assessment tools (BSATs) available to promote economic, environmental, and social sustainability by meeting design and construction requirements. The number of registered tools is currently more than 400 [194]. Over the last three decades many green buildings have been certified, and each new case makes the issue of the development of sustainable residential buildings more prominent, starting a virtuous circle. The Leadership in Energy and Environmental Design (LEED), the Comprehensive Assessment System for Built Environment Efficiency (CASBEE), the Building Research Establishment Environmental Assessment Method (BREEAM), and the Wellness (WELL) Building Standard are already established and recognized green building certification systems (GBCSs) that assist the construction industry in mitigating the environmental impact of buildings and achieving better performance throughout their lifetime [195]. Most of these certification systems, however, have been designed with a specific region in mind and different climate conditions, geographical features, and government policies may lead to sustainability differences across regions [193]. To address this issue, many researchers are already trying to transpose recognized green building rating systems to developing countries adapting them to their specific features, with examples ranging from Kazakhstan [196] and Iran [197] to countries in sub-Saharan Africa [198] and Qatar [199]. Rapid changes in the living conditions around the globe mean that existing green building rating systems need to be constantly updated in this respect, too. The COVID-19 pandemic and the related lockdowns hit our societies everywhere, disrupting almost every part of daily life, including business, lifestyles, healthcare systems, education, economy, and tourism. Such unexpected changes, with people stuck at home for long durations, brought us to a new reality. This new reality should be analyzed and taken into account in future decision-making. Since the COVID-19 pandemic and the changes it brought will likely stay with us even when the pandemic is over, many people in academic circles are re-examining the current sustainability approaches pushing towards new horizons [193]. Mohammadian et al. [200] argue that four new sustainability pillars, directly or indirectly interrelated, namely, educational, cultural, technical, and

political ones, should be added to the conventional group of three, which includes economic, environmental, and social pillars. Other researchers state that the main focus in LEED, BREEAM, and other current sustainability rating systems is the environmental aspect of sustainable development (indoor environment, and energy), whereas the social aspect lacks proper attention [201]. Possible effects of the current pandemic on the short-term and long-term transition of sustainability have been analyzed by Kuzemko et al. [202]. They predict a fall of electricity prices and demand in the energy sector. Investments could move away from current industries and carbon-intensive fuels. Globalization and interconnectivity conventions could be challenged, leading to changes in politics and multi-scalar policies. The pandemic could also be an opportunity and impetus to move away from unsustainable practices towards more sustainable ones, for example, to exchange driving for walking. It is not the first epidemic to leave a mark in the built environment: cholera and plaque pushed towards the development of green spaces and new wastewater routes; a fight with tuberculosis led to the increase of sunlight in housing units; and the SARS-COV-1 outbreak led to the improvement of ventilation systems [173,193].

### 2.3. GREEN HOUSING

The real estate industry was severely affected by the COVID-19 in both the residential and the commercial sectors due to travel and site-visit limitations, rent sustainability issues, and a decrease of or higher uncertainty about disposable income [203]. The real estate market, as for other productive and commercial sectors, in the short and mid-run, will not tend to move independently from the context of economic variables [204]. During the lockdown, houses became more important. It can be assumed that household preference of a new demand could emerge after this crisis making households looking for more comfortable houses since this asset will increase its importance for living and working. Similarly, the commercial real estate sector will change due to lower rent sustainability. However, the main expected change is related to the building type and the standards requested by tenants in the new economic environment. Household investment prospects will change. Housing demand will need products (new or recovered) suitable for the times—high-quality properties capable of offering a safe and healthy living and working environment. The COVID-19 emergency highlighted that domestic spaces have become obsolete from a functional point of view, especially in current times of smart-working and minors being forced into social and home isolation due to unpredictable health emergencies. Residential and office real estate sectors, once distinct, today tend to overlap with each other. The housing market will be stable, but the change in commercial real estate markets will accelerate [205]. For real estate and property owners and users, there may be changes in credit usage, rental, and contracts.

COVID-19 put the spotlight on health protection in buildings [206]. Existing efforts combined with new transformations may help address urban health inequalities stemming from socio-spatial structural injustices for the benefit of cities and all their residents to make them better prepared for, and more resilient to, COVID-19 and other similar crises we may face in the future [207].

Tokazhanov et al., argue that the COVID-19 pandemic has given us lessons, and changes in sustainability requirements for residential buildings should be expected and evaluated [177]. After COVID-19, new designs of living spaces may be introduced in sustainability requirements for residential buildings with emphasis on protective indoor health and safety measures, more intimate and greener spaces, new touchless technologies, better communication technologies for remote services, and improved control of light, humidity, air quality, temperature, etc. For now, the building sustainability rating methods in existence have primarily favored “environmental impact” and “energy performance”. A significant shift is expected towards an emphasis on “social and health” aspects. The authors suggest sustainability requirements for residential buildings need a review with a marked shift towards “social and health” aspects in sustainability rating methods for buildings, possibly with the support funds from expected COVID-19 stimulus measures for construction and current, as well as future green stimulus packages. Sustainable technologies mainly need to tackle the specific issue of improving the record regarding

increased consumption of energy and water as a response to environmental needs. “The development of novel building codes and green certificates for the post-pandemic residential buildings and/or the modification of existing codes and certificates considering particular pandemic needs” are seen as future efforts driven by requirements with a view to resilient design solutions and possible pandemic scenarios [177].

To cover special pandemic-related requirements, this research [193] proposes a particular set of sustainability indicators. The focus on particular sustainability pillars is different in various GBCSs (BREEAM, LEED, WELL, and CASBEE), as has been their response to pandemic resilience requirements. Some green certificates (GBCSs) have placed a lot of attention in a human-centered assessment of the sustainability of both residential and non-residential buildings and a reflection on the benefits of green buildings in the COVID-19 period is addressed [208].

Insufficient readiness for waste and wastewater management has been noted in all GBCSs and they all need modifications to improve their adaptability to pandemic conditions in line with existing and emerging post-pandemic requirements. A realization has dawned that modern life is possible without drastically harming the environment. It has involved taking a look at what the globe might look like without the use of fossil energy sources. This has encouraged hope that people could survive this pandemic while ending up in a healthier, cleaner world [193].

Air pollution, air quality improvements, wildlife, global migration, sustainability waste management, and waste fires were the focus of the researchers [205] who analyzed a summary of the existing reports on the impact of the COVID-19 pandemic on the environment. Many regions—Italy, France, Spain, Los Angeles, and Wuhan in China among them—observed a noticeable drop in air and water pollution. The crisis saw a rapid growth in health waste threatening the environment [205].

An analysis of occupant health in buildings by Awada et.al [190], covering both normal times and extreme events, the COVID-19 pandemic among them, shows that undermined Indoor Environmental Quality (IEQ) may expose occupants to a higher risk of catching many diseases exacerbated by both economic and social forces. The estimated annual cost linked to sick building syndrome in commercial workplaces is between $10 billion and $70 billion in the United States alone. During a global pandemic and other extreme events, occupants, facility managers, and designers need pragmatic guidelines on ways to reduce health risks in buildings. An interdisciplinary approach may help, and common standards and frameworks should be established with occupants rather than the building as the main focus. We should find ways to design buildings that support health and happiness [190].

The ability to recreate in public green spaces was seriously affected by the COVID-19 pandemic. To compensate this restriction and feel like they are away while at home, people turned to houseplants and outdoor green views. Research shows that exposure to more greenery had positive effects on the mental health of students forced by COVID-19 to spend most of their time at home [207].

The COVID-19 pandemic has hit many industries, with solar energy among them. Malaysia, in its efforts towards low carbon society beyond COVID-19, has plans to install rooftop solar panels, new grids, and LED street lights and earmarked about US$2.9 billion for that purpose. To accomplish this vision, the government, businesses, and small players should work hand in hand [207]. Consequently, this article has undertaken a review of the current status pertinent to renewable energy in Malaysia. Furthermore it also reviews the initiatives taken to promote solar photovoltaic (PV) technology before the pandemic for meeting energy demands via a low-carbon pathway.

Energy demand is often uncertain, and the COVID-19 pandemic has only made things worse. Researchers [208] investigate the impact of the COVID-19 confinement measures on energy demand in buildings and use Urban Modelling Interface to simulate various scenarios. The COVID-19 outbreak comes in waves and a few more of them are possible. We should prepare for their impact by understanding related seasonal energy patterns and performance and with appropriate new policies able to withstand future long-term shocks. It is vital to set new building standards for extreme crisis conditions with guidelines for building design, ventilation rates, and lighting/equipment power density in an effort to

support city—or even region-level policymaking for planning new areas, their energy supply systems and infrastructure, design of confinement measures, and energy system options to make sure different buildings will not be short of energy [208].

Urban design will inevitably be affected by the current COVID 19 pandemic highlighting the need for scalable smart city solutions, emphasizing the importance of public health and safety and exposing the need to invest more in public health care and infrastructure in the built environment [209]. This study [190] shows that architecture and urbanism have a potential in epidemics control and prevention and can actively contribute to human health. The authors investigate links between the scale in the built environment, epidemiology, and proxemics, as well as between population density and mortality rates. Solutions through architecture and urbanism are possible at multiple levels from individuals to shopping, transport and mobility ideas. They can be individual distancing and isolation; building-scale hygiene solutions; humidifying, ventilation, and filtering for indoor air control; social interaction solutions in the form of public spaces between buildings; intermediate housing; the scale and distribution of remote work; smaller shops closer to home; autonomous taxies, shared rides, bicycling, and walking; and mixed solutions spanning entire neighborhoods. We need to determine the role for architecture and urbanism in pandemic-related social resilience management.

Kapecki [210] examines the impact of humanitarian, financial, and environmental crises on sustainable development with a focus on housing. Crisis-hit economies, at local scale or globally, suffer economic, ecological, financial blows, and now, because of the latest COVID-19 crisis, a humanitarian emergency. Because of that the development of a sustainable economy, and sustainable construction in particular, is left on the sidelines [210].

The author believes that this catastrophe will teach us a lot and will leave us more open to all activities. Among the activities, sustainable construction should play an important role. In the housing industry, green and sustainable, energy efficient construction so far makes only a small share of total residential construction, but in public buildings sustainable construction has dominated the market. There are wide gaps between residential and public construction and lack of green housing may make competing with the achievements in public architecture difficult. As countries imposed lockdowns one after another, some of them plunged into economic stagnation. The lockdowns also revealed a lack of safe housing so important for survival during the pandemic [211].

## 2.4. COUNTRIES, CITIES, AND HOUSING IN THE ERA DURING AND POST COVID-19

There would be considerable benefit in having more interdisciplinary researches focusing on the analyses of three-way interactions pertinent to COVID-19. The interest is on the impact the related housing policies of countries/cities have on green housing and the betterment of the lifestyles for their residents. Conversely, it is also important to investigate how the residents themselves as well as the housing policies impact the dispersion of COVID-19. Such analyses need to treat all the named components as interacting and, thereby, have an integrated methodology as their bases.

### 2.4.1. Real Estate Policy in Countries and Cities: Responses and Challenges

COVID-19 disrupted the normal flow of life in the United States, with state and local governments issuing orders to stay at home and allowing only essential businesses and services to stay open. Communities across the country were affected. With no vaccines or medical treatments available, social distancing interventions were a necessary move to contain the virus, but they also meant crushing economic costs to businesses and people. Among the direct impacts are job losses, reduced hours and incomes, food and housing insecurity, and permanently closed businesses. Even ordered to stay at home, people still could go out for outdoor exercise. In their effort to give residents spaces for safe exercising (and commuting) in view of the two-meter social distancing recommendation, several cities, including

New York City, banned vehicular traffic from certain streets leaving them exclusively to pedestrians and bikers. New Yorkers were offered about 11 km of open streets in and around parks. Recently the city announced new plans to add 160 more kilometers, add additional bike lanes and widen sidewalks in May. Similar measures have been introduced in Seattle, Oakland, and San Francisco [212].

Some experts even suggest that telework becoming a new normal will make living in a large city less desirable and people, no longer attached to their old offices, will prefer less populous, and thus more affordable, places. Politico, a political journalism company, published an article titled "The Death of the City", which argues: "For the first time since the earliest cities emerged in the Fertile Crescent some 6000 years ago, concentrated urban centers no longer have a monopoly on the economic and cultural connections that make civilizations tick forward" [213].

In an attempt to make tenants, and sometimes landlords, less burdened, many countries have introduced changes in their real estate policies [214]:

- The United States is a country where state and local authorities are in charge of many decisions, and evictions have been temporarily prohibited in at least 34 states. The federal government also prohibited evictions from a property with a federally backed mortgage loan or federally subsidized housing for a term of 120 days. Citigroup, JPMorgan Chase, and other major mortgage lenders suspended mortgage payments. Construction has been suspended on all projects in some U.S. states, with a few exceptions, medical facilities among them.
- Some countries in Europe are providing temporary mortgage relief, have suspended evictions or both, France, Germany, Italy, and the U.K. among them. Mortgage and rent payments have been suspended both for commercial and residential tenants in various European countries. France, Italy, and other countries have suspended construction. Official tax reliefs have been granted to retailers in Europe, while banks have been urged to be lenient and refrain from foreclosures for late payments.
- Some countries in Asia, Singapore among them, are thinking of new laws to grant six-month protection to commercial tenants who cannot pay rent. Some Asian landlords have offered temporary rental rebates and rent discounts.

Tenants, owners, and other entities have been offered a range of support measures around the world. These include a freeze of rent increases, rent reductions, suspended evictions, rent payment subsidies, and rental contract extensions for tenants; deferred taxes, suspended foreclosures, assisted bank lending, mortgage forbearing, and mortgage payment support for owners; and, in general, emergency shelter, support for construction industry and utility bill payment support [214].

In response to COVID-19, countries introduced a range of crisis-response measures in their housing policies, such as suspended or limited rent payments, tax reliefs for mortgage borrowers, suspended evictions or extra rules regulating landlord–tenant relations, eased macroprudential policy settings, expanded public capital spending on affordable housing supply, increased housing allowances, and relaxed land-use restrictions. Maintained for a long period, these measures may discourage from the expansion and maintenance of the housing stock, and put barriers restricting mobility, both labor and residential, in the longer term. Financial and economic resilience may also suffer [214].

In the ongoing COVID-19 crisis, cities are the first line of response. Measures are introduced nationally, but each city is a key to their implementation. They also act as laboratories of innovative and bottom-up recovery strategies. The shift towards green, inclusive, and smart cities was already in progress before COVID-19, but the pandemic has sped up this trend. In our efforts to build back better cities, this policy note offers 10 key lessons learned from the crisis [215]:

1. Various countries suffered different impacts from COVID-19, but policy responses were often very similar across the world. It is important to customize approaches with local situation and the needs of local people in mind.

2. The health crisis has hit economic and social life hard with various cities suffering different consequences. Their recovery options and possibilities depend on their openness to trade, labor market structure, and industrial composition.
3. A shift from the emphasis on increasing mobility towards expanded accessibility was already happening, but this rediscovery of proximity offers an opportunity to speed up the process by looking at urban design and planning and public spaces from a new angle.
4. The pandemic laid bare striking inequality across places and people, and this inequality was particularly glaring in large cities, where vulnerable groups such as the elderly, women, the poor, and migrants have been disproportionately affected.
5. Urban density is not the key factor in this health problem—the quality of urbanization and structural inequalities are. Thus, tighter clustering will likely continue to be a source of benefits rather than concern.
6. A shit towards digital life, especially prominent and of great significance during the pandemic, will become entrenched as part of a "new normal", although remote work possibilities vary both within and across countries.
7. As people are becoming more environmentally aware, thanks to the "Greta effect" and "Zoom effect", circular economy and clean mobility have become more acceptable goals for transition, both socially and politically.
8. Governance has also been affected by COVID-19, due to changing trust in authorities, especially local politicians. In some countries people trust them more, but less in others.
9. Resilience needs more emphasis, as the disrupting effects of COVID-19 show. To achieve resilience, cities need to prepare for future shocks better by setting guidelines what persons have to take action, what their actions should be, at what scale measures should be applied and how to proceed in case of a crisis.
10. Strategy, policy, planning, and budget need an overhaul, and global agendas such as the Sendai Framework, the Sustainable Development Goals (SDGs), and the New Urban Agenda can help with this aim.

After the initial short-term responses to manage the crisis, including local service delivery, workplace and commuting, social distancing, vulnerable groups, citizen engagement, support to business and other aspects, cities now have turned to long-term recovery strategies aiming to become greener, smarter, and more inclusive ones [215]:

- Moving towards recovery, cities have taken many inclusive measures to address structural inequality and close the gap. Their measures include support to vulnerable households, construction and renovation of affordable housing, and local business support and employment.
- Looking forward to the future after COVID-19, many cities are already planning and making investments to ensure economic recovery is accompanied by environmental sustainability with a focus on energy efficiency and green modes of urban mobility.
- As digitalization has been one of the key emergency responses to the pandemic, many cities are adopting smart city tools and making their use a more permanent aspect, at the same time monitoring the risk of spreading infection and staying alert. As cultural resources, municipal services, information, and participation are moving online, the virtual space is becoming more and more integral.

Even when the COVID-19 pandemic is over, COVID-19 will likely stay with us. The pandemic is a public health emergency with attempts to protect the health of people and limit the spread of disease. At the same time, the pandemic and its aftermath is prompting cities to look for new ways to deliver services, plan spaces and resume economic growth. In the context of the COVID-19 pandemic, 33 latest city strategies to achieve long-term recovery and ensure resilience to future shocks are summarized as broad categories of inclusive recovery and green recovery [215]:

- Inclusive recovery. Social inequality has existed before, but the COVID-19 crisis puts an additional emphasis on the importance to address this issue. The crisis has revealed shortages of affordable housing for low-income people and families, as well as the risks of infection the inadequate housing poses in lacking communities. For that purpose, many cities launched public policy or investment initiatives with an aim to address the shortage of affordable and adequate housing and make disadvantaged residential areas better.
- Green recovery. As communities start recovering from COVID-19, cities will have many opportunities to emphasize ecological solutions in their economies, which, in addition to pathways to new jobs and long-term local economic growth, can also bring lower CO2 emissions, make communities better prepared for climate related risks (e.g., heatwaves or flooding) in the future, and improve urban environments (e.g., higher biodiversity, and lower air pollution). As one city after another across the globe imposed lockdowns, car traffic significantly dropped in most cases, which, in turn, led to cleaner air and lower CO2 emissions. Regions with lockdowns saw a 50–75% decrease in road traffic flows and major cities experienced drops in rush-hour traffic congestion as high as up to 95%.

During the pandemic cities are upgrading various urban solutions to achieve maximum energy efficiency and reduce energy costs in their buildings after COVID-19. Experience shows that investment in energy efficiency and retrofitting not only reduces emissions but can also drive economic activity and job creation in the construction sector [65]. Urban density and urban form (compact or sprawl) are the advantages that could be used by all levels of government towards green urban economies with climate-resilient and low-carbon urban infrastructure. Designing and construction of green buildings and streets, renewable energy production and procurement, where feasible, and other similar solutions of spatial and land use planning with future in mind would help to achieve the goal [215].

The COVID-19 and the related pandemic caused serious disruptions in the construction industry hurting the housing sector. Households were also suddenly struggling with income shortages hitting their ability to pay for shelter. In response, governments introduced many different protection and support measures for tenants, mortgage-holders, lenders, and builders [216]. To visualize the fallout of the crisis in the construction industry better, [216] looks at web-search data. Having then reviewed the measures taken by governments, Organisation for Economic Co-operation and Development (OECD) [66] concludes that, in addition to benefits, some of those relief measures might create inadvertent inefficiencies and make housing supply less responsive to the evolving needs of society and changing demand; hence, the measures have to be phased out as planned. Recent empirical findings led [216] to a conclusion that immediate rescue measures should transition gradually to recovery-oriented policy settings that can support the development of sustainable, inclusive, and efficient housing markets.

As COVID-19 was spreading, the pandemic hit the real estate sector around the globe. With countries scrambling to contain the virus, work in construction sites in many places stopped completely or to some extent, leading to loss of income and revenue for households and enterprises alike. Because of that various segments of the property market faced gloomy prospects to different degrees, as some countries introduced stricter lockdowns than others and at different times, and the public health crisis was also of different severity. The housing sector suffered a particularly serious blow, but governments were quick to introduce a wide range of measures to mitigate the adverse effect of the crisis on lenders, borrowers, builders, and tenants. Among them are measures that aim to preserve near-term affordability. If maintained for an extended period, however, they may discourage businesses from the expansion and maintenance of the housing stock, and because of that, in the longer term, residential and labor mobility may suffer. Economic and financial resilience is another area that may be undermined. Kept up for too long these measures—most, if not all, meant to be temporary—can cause difficulties with achieving a robust recovery. They can also make the housing market less responsive to the evolving needs of society. As emergency support measures went into force, eviction procedures were suspended, mortgage and rent payments deferred for a time, and utility payments in some cases postponed. During lockdowns,

most national as well as local governments introduced certain measures to provide shelter for the homeless [215].

To facilitate the recovery of homebuilding and ensure that the supply of housing matches evolving demand and the needs of society better, land-use restrictions need to be eased. Greater benefits can be achieved if such reforms are part of an integrated spatial planning framework spanning various hierarchies and government sectors. The reforms should promote housing construction, make housing more affordable, as well as improve neighborhoods and avoid excessive differences in the access to social infrastructure, transportation systems, and public services across different urban areas. Another benefit of the promotion of new residential construction is that a requirement for new buildings to comply with certain environmental standards could speed up the move towards low-carbon economy. The COVID-19 crisis may lead to lasting interrelated changes in housing demand and work organization that could be accommodated by facilitating construction and redevelopment. Living in lower-density areas and working remotely could be new preferences. Urban–rural divergences then would slow down or even be reversed relieving the current demand pressures in very dense areas. A growing uptake of remote work with flexible workplace would also mean that some office spaces in city centers would be free for conversion to residential units if land use permits the change. Such shifts could help reduce the gap between regional home prices and, in turn, residential segregation [215].

### 2.4.2. COVID-19 and Its Possible Effects on Future Homes

Affordable housing movements and the COVID-19 crisis are changing the definition of "quality housing". Alternative ways to organize and use living spaces and new models have been proposed [219]:

1. New or adjusted forms of shared living, co-living models in particular. Issues such as human connection, flexibility, and cost could be addressed by making this form of housing available to everyone.
2. In light of the blurring lines between work and home life, homes could become multipurpose spaces where people live, work, and spend their free time.
3. Private Rented Sector (PRS), Build to Rent (BTR), multifamily schemes and other models of managed rentals. Technology could also facilitate real-time residential management.
4. Lease-to-own, co-investment, ownership unbundling, collaborative forms of the reverse-annuity-based French viager system, and other tenancy–ownership options to access new housing.

In times of the COVID-19 pandemic, our homes are no longer just living spaces. They are now places where we work and exercise, and where our children attend lessons or lectures. They have made room for new hobbies and hosted happy hours at home. Real-estate experts speak about changing homebuyer preferences due to COVID-19 and predict possible shifts in home design in view of this new normal [220].

As the COVID-19 pandemic hit, almost every aspect of our life has changed, including preferred locations and forms [221]:

- Suburbs give way to exurbs. With many people forced to work from home, commuting in no longer a tying factor limiting the choice of housing. Thus many people now prefer to leave cities with their soaring prices behind and favor more remote areas. Since telework and remote learning have settled indefinitely as typical forms, many have no intention of coming back. Closer suburbs are still popular too, but low supply and large groups of motivated buyers are driving a sprawl. Among attractive features we still find proximity to the city, sidewalk-lined centers, and accessibility to shops.
- Notable changes have happened in the condo market. Condos are declining in popularity. One of the reasons is that the shared areas previously presented as added value in many condo buildings are now seen as risky inconvenience. Figuring out how to stay two meters apart in an elevator is too bothersome. People are now giving up their condo homes and moving to single-family houses: the range of amenities may be smaller, but you can remove the face mask as soon as you are

inside. Another factor is the price, because even the cheapest city condos cost more than suburban homes where you also get more space. Both more space and a lower price can motivate the move.

COVID-19 has changed housing interior trends and Rizzato [222] analyzes a few of them:

- Soundproofing and privacy. Big open plans seem to have fallen out of favor. No more kitchens, sitting rooms, dining rooms, and leisure rooms combined in one space.
- Healthier spaces. Germ-resistant flooring and surface materials, smart toilets, air purifiers, new air and water filtration systems, indoor air quality monitoring, in-furniture auto-cleaning technologies, automatic cleaning, and ultraviolet lamps.
- Voice Control and user-friendly technologies. A shift caused by the need to avoid touching the buttons of an elevator and other surfaces.
- New spaces for new functions. Online shopping, drone deliveries, and dedicated package drop-off areas for home deliveries.
- Greenery. A boom of indoor gardening and vertical gardens is expected. They can improve indoor air quality in our homes and reduce stress [222].

The COVID-19 pandemic has forced limited or zero access to common areas and non-essential amenities in residential buildings. More and more people, however, expect luxury amenities in multifamily communities [223]:

- Health-related amenities. A gym or fitness center, membership to local gym (discount or free), building-wide social distancing measures, contactless food delivery, free masks and gloves, and hand sanitizer stations.
- Entertainment-based amenities. Outdoor grill areas, recreation rooms, rooftop deck or patio, basketball and/or tennis court, pool, and movie theatre rooms.
- Convenience-based amenities. Free broadband internet and cable TV, in-building convenience store, package lockers, electric car charging stations, exclusive meal services and/or a virtual restaurant, video intercom systems, package alerts and mailrooms with mailroom management software, valet services, dog run, or park.

Around four out of ten workers took up remote working for the first time; thus, many people are spending much more time at home. For families with children homes have also become makeshift playgrounds and schoolrooms. The current stock of housing, with issues such a lack of personal space, high-speed internet, outdoor space, or natural light, poses the question of the adequacy of our homes. COVID-19 is not the first and hardly the last public crisis that may disrupt our everyday lives, and remote work may become prevalent in view of its current relative success. Public authorities should, therefore, review their planning guidelines with homes as places to truly live in, rather than just eat and sleep, in mind. As over the medium-term (at least) private developers of housing are likely to be in partially suspended mode, waiting to see the direction the market takes, ready-to-implement public housing projects are a great opportunity for nations to restart construction work, making sure it is safe to bring workers back on site, and this way to give their economies a much-needed boost. In the current climate of economic and financial uncertainty and rock-bottom bond yields, residential properties can be seen as an attractive investment for prospective private landlords looking for ways to convert their cash to sources of rental income. The post-COVID period could, therefore, see the monetization of housing, prevalent since the financial crisis of 2007–08, keeping up and going further [224].

Ogunnusi et al. [225] examine the effects of COVID-19 on real-estate-related deals and the prospects of the construction industry by means of quantitative measures. Built asset procurement professionals were surveyed and the results of this survey reveal certain issues with workflow and supply chain disruptions, new policies, workforce anxiety, as well as COVID-19 vs. Force Majeure revisions in standard construction contracts. The necessity for virtual working and unique design considerations, however, presents new opportunities to modern procurement planning. The research by Ogunnusi et al. [225] can serve as a basis for those developing additional contingency plans and a new working strategy in situations of social distancing caused by the pandemic. The study by Gamil and Alhagar [226] looks at the effect of

COVID-19 on the survival of the construction industry and classifies the impacts into different groups, including human and economic resources. The biggest impacts of COVID-19, as the study by Gamil and Alhagar [226] shows, are labor impact and job loss, the suspension of projects, cost overrun, time overrun, and financial implications. Bailey et al. [227] look at the impact of COVID-19 pandemic and its management with focus on construction projects were the pandemic has been slowing processes and leading to disruptions and delays. Legal implications, however, vary between contracts and across countries. Some projects were suspended and delayed. Businesses must assess health and safety risks in line with medical, scientific, and government guidelines. In indoor spaces, for instance, people face higher risk than those working outside. Whereas no one could foresee COVID-19 and its outcomes, it can be considered a case of force majeure, which in any standard form of contract (FIDIC among them) usually affords contract extension spanning the duration of the pandemic with no compensation for cost [227]. The findings by Shibani et al. [228] show that lockdowns and social distancing rules caused by the COVID-19 pandemic provided a serious hit to construction companies involved both in residential and commercial projects. In response, construction companies chose the strategy to stay on good terms with their suppliers and ensure the safety of construction teams [228]. Ataei et al. [229] review the immediate response of the construction industry to the COVID-19 pandemic and the challenges it poses looking at the impacts on projects related to timetables, delays, financial difficulties, as well as new and shifting regulations. Hook [230] argues that this pandemic may force some engineering and construction companies to look for funding and streamline debt, or they risk bankruptcy. Engineering and construction companies face new realities in the future with changing markets and public infrastructure investment, as governments look for ways to jump-start recovery [230].

In the times of the ongoing COVID-19 crisis, Zillow has presented the Top 10 housing trends for 2021 related to life in this environment in the nearest future. Zillow's top housing trends for 2021 are as follows [231]:

- "Zoom Rooms". Zillow surveyed Americans and discovered that the top reason they would consider a move, if they were to continue working remotely at least occasionally, is that they would prefer a home with a dedicated office in such case. In 2021, employers will give a clearer message about the possibilities of remote work in the future, and this could encourage people to look for homes with more space, as tired of working in their kitchens people will want more permanent solutions for their work at home—to have a quiet dedicated corner. As of November, an increase of 48.5% was recorded year-over-year in the number of listings mentioning "home office" or "Zoom room".
- "Homecation" Amenities. As people are forced to stay home and have lots of time, they are thinking up creative solutions to make themselves a vacation at home. In 2020, "pool" was the most popular search term at Zillow, with "waterfront" and "dock" also in the top ten. Homeowners may also be looking for ways to add a touch of luxury at home with a relaxing rain shower or spa-like bathtub, and home buyers, according to Zillow, paid extra for amenities that make their home feel like a resort. A mention of a free-standing tub typically meant the listing sold for a price 5.5% higher than expected, while the keyword "spa-inspired" added a 1.8% price premium. The rise of telecommuting means that more people will be able to take permanent residence in their favorite vacation destination. Key West, the Jersey Shore, and Cape Cod are just a few of areas typically considered vacation destinations with page views of for-sale listings there up nearly 50% compared to previous year.
- Intergenerational Living. This form of living will become more popular as, for financial and health reasons, both young and old people move in with family. Today about 16% of Americans, according to Generations United, live in households of more than one generation, and the share of young people (Millennials and Gen Z, especially among renters) moving back in with their parents reached historical heights in 2020.

- Gourmet Kitchens. With fewer opportunities to eat out, the year 2020 inspired people to look for new things they can bake in their kitchens. In 2021, homeowners will want to go further in this endeavor and level-up with more new culinary masterpieces. As a result of social distancing recommendations, 41% of people value a well-equipped kitchen more than before, according to a previous Zillow survey. In the next year, more people are likely to prefer better-equipped space for their new culinary skills.
- Backyard Oasis. Social distancing recommendations have highlighted the importance to have a safe and functional yard and 41% of people, according to a Zillow survey from the Harris Poll, now value a large outdoor space more. A few easy touches and your backyard can become a relaxing oasis for the whole family with an additional benefit of a higher resale value of your home. Listings mentioning "firepit" sold at a 2.8% price premium, and "outdoor kitchen" added extra 4.5% to the price, according to Zillow. An addition of outdoor lighting and/or smart sprinkler systems also makes your backyard look more attractive to potential home buyers and may speed up the sale of your home up to 15 days.
- Smart and Safe Tech. Home disinfection has become a vital part of our daily lives, and smart-home technology is rushing to the rescue with products such as self-cleaning toilets, bidets, and touchless appliances. These are often still niche products, but gradually they will become standard fixtures in home design. When social distancing rules will be lifted and guest visits will become a normal thing again, more and more homeowners will look for creative solutions to keep their spaces clean, but also chic. By incorporating thoughtful innovation into home products, robotic vacuums, electronic-assistant controlled lights, voice-activated faucets, and other features have brought into homes new ways of cooking and cleaning. Buyers increasingly see smart home technology as an attractive option. Listings mentioning a smart light sold seven days faster than expected, and those with a smart thermostat mentioned in their description sold six days faster than expected, according to Zillow. Looking for ways to keep their families safe and germ-free, homeowners will be more likely to add a new touchless faucet and similar fixtures and fittings to their homes.
- Small City Living. With ever more telecommuting opportunities, many people looking for a new home now have new ideas of where and how they want to live. As the need to be close to jobs in cities is falling, smaller, more affordable communities and wide open spaces may become the main preference for homebuyers in 2021. Search traffic data is already showing this trend. Pierre in South Dakota, Borger in Texas, Vernal in Utah, and other similar small cities contributed most to the growth in out-of-town search traffic, compared to the previous year; out-of-town search traffic in a dozen markets such as Jackson in Wyoming, Pierre in South Dakota, and Hudson in New York doubled this year. In case of small cities, with populations between 54,000 and 137,000, newly pending sales have increased 34.3% since last year, and YOY pending sales have been positive since July. The preference to live in small cities will only keep growing as remote work becomes a more established practice and give renters opportunities to become homeowners.
- Health and Wellness at Home. Nationwide, people were quick to adapt to new restrictions, setting up mental wellness spaces or fitness clubs right at their home. In November, health and wellness areas were mentioned in 4.1% of homes listed for sale on Zillow. The number of listings mentioning "health and wellness" has been increasing since early summer and peaked in November with lockdown orders renewed and fewer daylight hours for outdoor activities because of the approaching winter. Physical health, however, is not the only priority homeowners have. Isolated from social activities and loved ones, people will be more inclined to set up their own private areas for their mental wellbeing activities such as meditation and reflection. According to Berks Homes, the number of homes with an extra bedroom in the basement or over the garage has increased this year. These new private spaces added to homes may be converted to meditation rooms or become a quiet space to spend some time away from chaotic life.

- Pet-Friendly Living. Telecommuting gave many people the opportunity to spend all their day at home and better ability to take care of pets. Twenty percent of respondents surveyed by Nielsen in July said they had adopted one or more cats or dogs between March and June, compared to less than 5% over the same period last year. As more furry new best friends join families, the demand for pet-friendly rentals is growing and landlords use these added benefits to entice renters. According to Zillow, 73.1% of residential properties listed for rent allow pets. Because the number of families with pets is growing, Zillow reckons they will expect pet-friendly features in their next home. In 2020, Zillow analyzed available data and found that listed properties with a fenced backyard mentioned in their description sold 6.8 days faster than expected and those with a pet shower or dog wash mentioned added a 5.1% price premium over similar homes with no such amenities.
- Rise in Demand for New Construction. Zillow has observed a significant increase in traffic of people looking for new construction homes, up 82% in the third quarter of 2020 YOY. This means more homebuyers are interested in the ability to personalize their home and want to live in a clean, new space. Surveyed by Zillow in 2020, over a quarter of households who bought a new construction home said their choice was determined by the wish to customize home features, while another 37% based their decision on the fact that everything in the home was new and never used.

BIM means that each building has a virtual counterpart used throughout its lifecycle—from its design and construction through its operational life until its demolition. This virtual counterpart makes it possible to track and analyze environmental metrics, energy consumption, and human activity patterns. Efficiency thus can be improved and desired outcomes (e.g., social distancing) promoted. Soon virtual counterparts will be used in the planning of and, later, adding adjustments to entire neighborhoods and cities. However, equity should be front and center when this point-of-no-return will be reached [213].

The COVID-19 pandemic pushed up the demand for more space and less dense living environments among consumers. With the U.S. housing market bustling this year as Americans encouraged by extremely low mortgage rates and remote work opportunities are looking for places to relocate, the condo market has not gained much. During the coronavirus pandemic, people looking for a new home preferred more space and privacy of single-family homes to dense cities. An exodus from cities to the suburbs in search of more space has been observed [232].

A new report by Zillow shows that more than a third (34%) of potential sellers prefer to stay out of the market for now, faced with uncertainties, mostly caused by COVID-19. An important role is played by financial anxiety: of the homeowners who are thinking of selling their current home in the next three years 31% say they are discouraged by the current precarious or uncertain financial situation, with 27% reporting recent employment changes with fewer hours or lower pay, and 17% mentioning a job loss or furlough; these reasons could make people less inclined to look for a new home. Another contributing factor is the uncertainty surrounding the place of work. A survey by Zillow shows that homeowners started to work from home more often in the past six months and this new arrangement is the most common change. Another survey by Zillow shows that two-thirds of people teleworking during the pandemic would consider looking for a new home if the ability to work from home occasionally stays after the pandemic. While homeowners wait for a clear signal from their employers when (or if) they will have to return to the office, however, those plans may be on the backburner. Almost 40% of the homeowners who are thinking of selling their current home in the next three years say they expect a more favourable sale price if they wait, suggesting they do not think now is the only time to get a good price, despite all-time high median sale prices, up nearly 11% YOY for the week ending 5th September. Sellers are once again optimistic, too: a Fannie Mae survey in September found a majority (56%) of people think now is a good time to sell, up from 29% with the same opinion in the spring. Potential sellers believe that home prices have not peaked yet. They are likely correct, but there is no clear “right time” to sell, because prices always tend to rise in the long run [233].

Density is usually associated with higher rates of mortality from, infection with, and transmission of, highly contagious diseases, COVID-19 among them [234,235]. An opposite conclusion can be drawn, however, from a U.S.-wide analysis of the relationship between COVID-19 infection and mortality rates and density in 913 metropolitan counties [236].

Connectivity makes a serious impact on COVID-19 infection and death rates. More in-depth research on measuring connectivity in cities and its impact on the spread of pandemic is, therefore, important. Future studies could reveal new aspects by developing and using more sophisticated internal connectivity measures; for instance, location-based social networks [237].

Confirmed virus infection rates are not related to density but confirmed virus death rates are inversely related to it. This fact is unexpected, important, and very serious with implications for transportation expenditures, regional planning, community design, urban redevelopment, congestion pricing, affordable housing, tax policy, smart growth, and almost all other urgent issues important to planners. It goes against ideas that, without data and analysis, might question the foundation of modern city planning that density is preferrable to sprawl, at least in some places such as urban and suburban centers [238].

The number of studies looking into the impact of density on highly contagious new infections is not high. In theory, people living in densely populated areas have more interactions with others, which may contribute to the rapid spread of contagion. However, dense areas may also mean better access to health care facilities and higher adoption of social distancing practices and policies [236]. The findings by Hamidi et al. [236] suggest the spread of the COVID-19 pandemic is facilitated more by connectivity than density. The most vulnerable locations are large metropolitan areas with tight economic, social, and commuting links with a higher number of counties. With higher movement of people (tourists, businesspeople) both inside such areas and with outside locations, the risk of cross-border infections is also higher [233].

Every aspect of urban planning practices has been affected by this pandemic. With high unemployment rates, its economic impact is already obvious. Months of social distancing, staying a home, and the economic crisis will lead to societal impacts. Environmental impacts are also expected: both positive ones from changed behaviors and, without the right measures in place, recovery-related negative ones from rebuilding the economy. The severity of all impacts combined will determine political impacts. Finally, technological impacts may open new opportunities to find ways to respond and prepare for this new future [239].

Facebook expects to see half of its employees working remotely by the end of the decade, and this expectation is not tied to the pandemic. Meanwhile, seven in ten Microsoft employees would like to continue teleworking after the pandemic ends. Among surveyed employers, 94% stated that productivity did not suffer due to teleworking, 27% noted an improvement in productivity, and 73% expect that at least a quarter of employees will work remotely indefinitely, with close to half of those reckoning that 50% of their employees will continue teleworking even when offices are safe to return to. Various surveys predict a shrinkage of office footprints, which, in turn, will open new ways to solve longstanding urban problems as transportation and land-use patterns shift. Downtown areas often lack housing, so some of the empty offices might be converted to residential units. Such endeavors will demand extensive investments from building owners. Government incentives and zoning changes are likely to be required making it a long-term effort [213].

Although a home in the U.S.A. typically costs about $263,000, a sharp increase in the number of “million-dollar cities”, according to Zillow, was recorded in 2020, adding 45 new U.S. cities to the pool of those with a typical home value of at least $1 million. No larger increase has been observed in at least a decade. The number of million-dollar cities is now 312, compared to 104 five years ago. The significant increase over the course of 2020 is the testimony of considerable activity in the market last year and surging demand through most of 2020 caused by demographic trends and the pandemic, with home values going up almost 7.5% annually in November. The year before, in contrast, saw the lowest rate of home value appreciation since 2013. The list of million-dollar cities is typically dominated by areas with

attractive natural surroundings, such as mountains or the ocean nearby. A great media package, including 3D imaging, virtual staging, and a floor plan with dimensions, give sellers a competitive edge [240].

Cities are making moves to protect homeless people. Among them, Chicago and Los Angeles, where resources have been prioritized for emergency shelters, Baltimore, where vulnerable homeless residents aged over 62 are being relocated from emergency shelters to motels, and New Orleans, where homeless people were also moved to a hotel. Various modes of transport have been impacted by the COVID-19 pandemic and the impact is huge. With transit use declines of about 97% in Chicago and San Francisco, and 87% for subways, and 70% for buses in New York, most transit agencies have cut their services down to hedge against financial loss. Other modes of transport also suffered with rider numbers at Uber 60–70% down in Seattle, and zero rides in New York where this type of services has been banned. Across major cities, Uber suspended its UberPool, a ride-share service. The story of bike sharing is different. Divvy in Chicago and other similar companies, in partnership with cities, offer their members attractive discounts during the pandemic. People increasingly are choosing biking over using transit as a safer option. Philadelphia is going with the trend and, to make its cyclists safer, has closed a 7-km street to vehicles; biking in Philadelphia is up more than 150% [212].

The impacts of digitalized workplaces will go along with, and be reinforced by, the digitalization of education, shopping, and entertainment. More people will regularly shop for basic goods online and brick-and-mortar retail stores will be mostly devoted to offering experiences. These trends driven to new levels by the pandemic will result in huge areas of obsolete asphalt. Perhaps we are not going see autonomous cars taking over roadways anytime soon and it might take several decades for this future to arrive, but the ever more popular ideas for converting parking areas to serve other purposes may be implemented sooner rather than later. The Christmas rush plays an important role in setting parking requirements, but this phenomenon may move increasingly online. In that case, the supply of parking spaces will exceed demand considerably. All these no-longer-needed paved spaces could then be converted for other uses such as urban green spaces or affordable housing. As people spend more time at home, they are likely to ask for more activities—from green landscapes to entertainment options—within a walking distance. How does the concept of land use change when people do everything at home: live, work, shop, study, and produce things? Does the concept of a residential district still have a meaning? How is it different from an office district, a commercial district, or an industrial district? The land zones set in the past may no longer correspond to the way people are actually living and working in the future. A more inclusive and flexible system will be required where people will be able to adapt. This trend opens many opportunities [213].

Industry 5.0 expects to resolve the increasing need for personalization, since Industry 4.0 was unable to accomplish such [241]. Industry 5.0 endeavors to personalize its products and services on masse, like never before. The experiences of its clients are also included in this process. Japan describes Industry 5.0 as “Society 5.0”—a revolution of “human touch”—as follows: “A society that orients towards the human being balances between a system of economic advancement and social problem resolution, which integrates cybernetic and physical spheres very well” [242]. “Vital entrepreneurship” and “vital marketing” are the activated goals of personalization including those companies that are constantly able to foresee and react to ever-changing client needs (by gathering and analyzing data in real time). Such companies become a part of the daily lives of their clients [243].

Industry 5.0 is now seemingly progressing towards harmonious technological and societal systems that deliver a customization of products and services en-masse, which are all personalized [92]. An increased human–machine interaction is the primary difference between Industry 4.0 and Industry 5.0, according to [245]. It encourages personalized expressions among people by their use of personalized products and services. The emphasis in the work by Yin et al. [246] that regards the future of technology and personalization revolves around human centrality.

Unfortunately, there is very slow movement of the Internet of Things towards humanization. This has inspired Kaklauskas et al. [247] to foster the idea of humanizing the Internet of Things among academic and business communities. Analyzing the affective Internet of Things, smart homes, ambient intelligence,

affective computing, BIM, smart and interactive buildings, and smart building systems constitute the presentation of the humanization of the Internet of Things by this research [248].

A number of researchers have also engaged in scientific studies focusing on individual thermal comfort and indoor air quality [249-258]. Personal comfort systems (PCS) are analyzed next as an example. PCSs in laboratory and field studies can appear in different forms, such as ceiling fans, radiant or convective heaters, and temperature-controlled surfaces on chairs, desks, and floors. Certain systems and devices have been designed to address individual thermal variability by permitting people to control their own thermal status. Thereby people are able to adjust temperatures to the degree of comfort for themselves. The warming and cooling stimuli on surface bodily areas can affect the entire body's thermal sensation [252, 259, 260, 261]; thus such systems are effective. A unique approach to PCS appears in the work by Wang et al. [251], who assess leveraging the time-dependence of human thermal perception. Embr Wave, which is a 6.25 cm2 wearable device, supplies dynamic, cooling, or warming waveforms to the inner wrist. A substantiating work of research is by Wang et al. [251], which concludes that this wearable device running on low power betters the thermal phenomenon, comfort, and satisfaction over the entire body. Meanwhile a study by Lopez et al. [262] discovers that a whole-body thermal sensation works more efficiently by cyclic heating rhythms than it does by continuous heating.

## 3. EFFECTS OF COUNTRY SUCCESS ON COVID-19 CUMULATIVE CASES AND EXCESS DEATHS IN 169 COUNTRIES

### 3.1. INTRODUCTION

#### 3.1.1. Alternative cross-cultural theories

There are ongoing debates (Gouveia and Ros, 2000; Steenkamp and Geyskens, 2012; Dobewall and Strack, 2014; Kaasa, 2021) regarding possible relationships between alternative cross-cultural theories and how these are related (Hofstede, 1986; Schwartz, 1999; Steenkamp, 2001; Inglehart and Welzel, 2005; Chhokar et al., 2007). Dobewall and Strack (2014) look at the relationship between Schwartz's and Inglehart's value dimensions. They examine both the country and the individual levels. The ranking of countries (N = 47) based on the Schwartz's paired dimensions of autonomy/embeddedness and self-expression/survival reached a maximum of similarity at r = .82, after which Inglehart's factor scores were rotated 27 degrees clockwise. Dobewall and Strack (2014) conclude that the two-dimensional value structures originally proposed by Inglehart and Schwartz share one dimension at the country level. Taking a conceptual approach, Kaasa (2021) explains a way to merge Hofstede, Inglehart, and Schwartz's models into a single system. This way, three sets of dimensions can be visualized as one system, and the results confirm several conclusions in the existing literature. When the relationships between different models are known, it becomes easier to compare the results of studies based on different cultural dimension sets as explanations of extraneous variables (Kaasa, 2021). Building on research of work-related values in more than 50 countries, Hofstede (1986) developed a 4D model of cultural differences among societies, and listed each difference with reference to the four dimensions of strong versus weak uncertainty avoidance, masculinity versus femininity, large versus small power distance, and individualism versus collectivism.

A set of 44 profiles was compiled, which suggests that nations fall into broad cultural groupings related to their geographical proximity, but are also affected by other factors, such as religion, cultural contact, shared histories, and level of development. These groupings are Western European, East European, English-speaking, Islamic, Far Eastern, and Latin American (Schwartz and Ros, 1995; Schwartz, 1999).

The aim of the World Values Surveys (Inglehart and Welze, 2010) is to serve as a comprehensive measure of all major areas of human activity, from politics and religion to social and economic life. Two dimensions dominate along the vertical and horizontal axes of the surveys, and explain over 70% of the cross-national variance in a ten-indicator factor analysis, namely, secular-rational versus traditional values

on the y-axis, and self-expression versus survival values on the X-axis. Each of these dimensions is also strongly correlated with multiple other important aspects (Inglehart and Welze, 2010).

Steenkamp (2001) looked at the two major cultural dimensions proposed by Schwartz and Hofstede and, by examining the cultural ratings of the 24 countries included in both Schwartz's and Hofstede's data sets, created four thorough national–cultural dimensions. While Steenkamp has derived his national cultural dimensions from Schwartz's and Hofstede's data sets alone, his study points out the common features between the two, and thus bears out the relevance of these earlier cultural theories (Hsu et al., 2013).

By looking at unique patterns of organizational and societal characteristics, Chhokar et al. (2007) analyzed 61 countries and grouped them into ten clusters: Anglo, Nordic Europe, Eastern Europe, Germanic Europe, Latin Europe, Latin America, Sub-Saharan Africa, Middle East, Confucian Asia and Southern Asia.

A Google (Google Scholar) search returned about 24,700 (549 search results returned by Google Scholar) results for the keywords "Hofstede's cultural dimensions theory," about 8,620 (229 search results returned by Google Scholar) for the keywords "Inglehart–Welzel Cultural Map of The World," and about 35,700 (235) for the keywords "Schwartz Theory of Basic Human Values." The number of citations in Google Scholar is 210,855 for Hofstede, 138,018 for Inglehart, and 126,253 for Schwartz. Steenkamp (2001) and Chhokar et al. (2007) are far less cited in the area of cross-cultural theories.

### 3.2. The spread of the pandemic, culture, and links between them

Even before COVID-19, the ways in which response to disease intersects with culture and politics were drawing the interest of researchers. Soper (1919), for instance, published a paper on lessons from the Spanish Flu pandemic in Science magazine over a century ago. Soper (1919) put forward three main factors that interfere with prevention: People underestimate the risks they face, by nature they are reluctant to confine themselves to rigid isolation for the sake of the greater good, and they have an unconscious tendency to often act in ways that can pose danger to themselves and others. The regression findings by McIntosh and Thomas (2004) showed a statistically significant contribution of political instability and income inequality with higher HIV/AIDS prevalence, whereas gender equality contributed to lower HIV/AIDS prevalence. Other important predictors were region and religion, with HIV/AIDS less prevalent in predominantly Christian Orthodox and Muslim countries, but more prevalent in Central, West, and Southern Africa. Among the media and public health indicators, none were statistically relevant (McIntosh and Thomas, 2004).

Social distancing seems to be a practice that is more difficult to engage in for people in more collectivistic cultures. Another important point is that there have been few previous attempts to assess the effectiveness of social distancing measures (Solomon et al., 2010). Power distance is an important factor contributing to the growth rate of the outbreak: higher levels of power distance are associated with lesser growth rates, whereas individuals in cultures with low power distance appear less willing to comply with directions without questioning their national authorities on how to change their social behavior (Mulki et al., 2015). Jarynowski et al. (2020) believe that for well-interconnected societies focused on maximizing utilities, the likelihood of being infected with COVID-19 is higher.

The linear regression model implemented by Messner (2020) regresses the exponential growth rate of confirmed COVID-19 cases on cultural, socio-demographic, and institutional variables associated with controlling the outbreak, case testing and reporting, and supporting the pathogen's route. While the effect of a strong institutional context on the outbreak is negative ($B = -0.55 \ldots -0.64$, $p < 0.001$), countries with a quality education system see higher pandemic growth rates ($B = 0.33$, $p < 0.001$). Older populations generally mean grave outcomes for countries ($B = 0.46$, $p < 0.001$). Where individualistic, rather than collectivistic, values prevail, the rate of pathogen proliferation is flatter ($B = -0.31$, $p < 0.001$), and the effect of higher levels of power distance is similar ($B = -0.32$, $p < 0.001$). Outbreaks are more serious in

societies with hedonistic values, namely where people seek indulgence, and are not willing to endure restraints (B = 0.23, p = 0.001) (Messner, 2020).

A positive correlation between the country-level resilience to COVID-19 and trust within society has been determined, as has one between the country-level resilience to COVID-19 and the adaptive increase in the severity of government interventions when outbreak waves occur. Societies, therefore, need to build trust if they want to be resilient to epidemics and other unexpected disruptions like the COVID-19 pandemic, which is unlikely to be the last (Lenton et al., 2021).

Whiteley et al. (2020) indicated that the factors impacting health include the state of the economy, the predominance of economic inequality, a sense of freedom when making life choices, and environmental well-being.

A high score on freedom-orientation for a country usually also means a high score on autonomy, individualism, and self-actualization. Meanwhile a high score on control-orientation also tends to display a high score on collectivism, embeddedness, and survival. This correlation supports the idea that there are statistically significant relationships between cultural factors and disease (Ren and Fang, 2016).

A greater number of outbreaks with COVID-19 cases are discovered, according to Maaravi et al. (2021), in counties with individualistic tendencies as opposed to those with more collectivistic tendencies. They also discovered that more individualistic people were also less likely to follow the rules for preventing disease in epidemics. These findings are pertinent when attempting to identify the reasons for how pandemics spread, when searching for optimal ways to get out of lockdowns, and, especially, when trying to convince people to get vaccinated with newly discovered medications for battling the virus (Maaravi et al., 2021).

The factors that tended to intensify the consequences from the pandemic were the following: high degrees of pre-existing poverty and inequality, a high percentage of informal or micro-firm workers, few jobs that could be feasibly accomplished from home, and a significantly large tourism industry share, along with considerable domestic unrest, violent riots, and/or civil wars. Additional factors proved to be comparatively small public sectors and tax revenue bases, limited fiscal space, and unstable admissions into international financial markets. Therefore, the countries that already had high poverty, informality, and limited fiscal space from the start (generally defined as developing economies) are expected to suffer the worst and the longest-lasting consequences of the pandemic (Djankov and Panizza, 2020).

### 3.3. Interrelationships between country success, sustainability, and COVID-19 indicators

To predict self-expression values, Inglehart and Welzel (2005) use various independent variables and a series of models. The correlation between differences in the scope of the welfare state and variation in gender equality is r = .77. Inglehart and Welzel (2005) found a staggeringly strong correlation of r = .90 across 73 nations, after examining the links between mass self-expression values that emphasize free choice and genuine democracy where societal institutions actually ensure free choice. In the regression analyses, therefore, socioeconomic factors alone (GDP per capita and the share of the workforce employed in the industrial sector) explain a substantial 45% of the variance between given societies on the dimension of traditional/secular-rational values. The culture-zone shift factor alone explains 59% of the variance on this dimension, while the combined effects of historical heritage and socioeconomic factors explain as much as 80% of this variance. Likewise, the socioeconomic factors by themselves explain 61% of the variance on the dimension of survival/self-expression, and historical heritage variables explain 52% of the variance on this dimension, while the combined effects of culture and economics explain 84% of the total variance (Inglehart and Welzel, 2005).

Researchers integrated epidemiological dynamics into a sovereign default model to examine this complex health, debt, and economic crisis and the measures to mitigate it. The global nature of the COVID-19 crisis demands international coordination in science, healthcare, and economic policy, as well as containment and mitigation efforts (Loayza and Pennings, 2020).

To prevent catastrophic consequences for COVID-19, the world needs global, regional, and national public health, as well as geopolitical collaboration (Moti and Ter Goon, 2020).

The political dimension (e.g., indicators that measure government effectiveness, political stability, democratic expression voice and accountability, political corruption, and legislative and judicial constraints) covers risks related to political processes and capacities to mitigate them with strengthened state transparency and accountability (Desai and Forsberg, 2020).

According to Desmet and Wacziarg (2021), the lowest levels of infection during the pandemic were observed in US counties with a large share of college graduates, followed by those with a large proportion of persons who had completed secondary education. They presented the results of an extensive investigation of the role inequality and poverty play, including median household income, for which they found evidence that locations with lower levels of educational attainment have been hit harder by the coronavirus. They also added two inequality and poverty measures—poverty rate and the Gini index within the bottom 99%—and their findings suggest that poverty positively predicts disease severity.

The developing world seems to have lower levels of COVID-19. Different factors have been named as explanations for this, including the various means applied for recording deaths and the overall younger demographic profile in Africa. Other factors include the availability of outdoor spaces, which more people use in their daily lives. People have also possibly developed higher levels of protective antibodies by surviving previously rampaging infections. It is also possible that certain developing countries responded more quickly, and applied more forcible measures in the fight against COVID-19, as a result of the unfortunate legacy of SARS, MERS, and Ebola in the very recent memories of numerous populations. The paradox is that industrialized countries continue to struggle, probably due to their lack of attention to the strategies executed by developing countries, which have in many cases displayed excellent preparedness and creativity during the pandemic (Mormina and Nsofor, 2020).

A strong sense of vigilance in civil East Asian societies was the singular element that resulted in avoiding the spread of COVID-19. People collectively adhered to the norms of wearing masks and socially distancing on a widespread basis as conscious practices to safeguard the safety of other people. This probably constituted the secret weapon that contained the spread of COVID-19 in East Asia (Liu et al., 2020). This highlights the sharp contrast between how East Asian societies behave and how Americans behave in the USA. The responses of US Americans to COVID-19 were highly individualistic, intellectually and affectively autonomous, and highly politicized (Allcott et al., 2020). There were great outcries among many people opposing public health measures that called for social distancing, travel restrictions, and mask wearing. Such measures were considered curtailments to the personal freedoms they felt the US Constitution had guaranteed them (Evans and Hargittai, 2020).

Germany managed to employ broad-based testing and healthcare measures, which held down its death rate significantly better than its neighboring countries did, although their economy has faltered at the same rate as those of other countries (Heath and Jin, 2020).

Desmet and Wacziarg (2021) analyzed the correlates of COVID-19 cases and deaths across US counties to determine factors that could explain the spatial variation in the severity of COVID-19 across the USA, and they found four key aspects. The first important aspect is effective density as a persistent determinant of COVID-19 severity. The second aspect is the disproportionate impact on counties with higher poverty rates, lower income, more nursing home residents, and bigger shares of African Americans and Hispanics, with these effects showing no sign of fading away over time. The third aspect is that certain characteristics—the share of elderly individuals or the distance to major international airports among them—initially make a strong impact but their effect fades over time. The fourth aspect is that, early on, Trump-leaning counties suffered a less severe blow, but then were hit much harder later. The COVID-19 blow suffered by Republican-leaning areas was less severe. This may have driven early development of behavioral and policy preferences related to party affiliation, resulting in less inclination to adhere to social distancing and mask-wearing rules, as well as lockdown measures. This view suggests certain preferences and attitudes had already been firmly lodged in the minds of local populations as the

pandemic spread to Trump-leaning counties, and this prevented a more decisive response to deteriorating local conditions. This, therefore, led to greater COVID-19 severity in Trump-leaning areas of the country (Desmet and Wacziarg, 2021).

A region with a high human development index (HDI), as Liu et al. (2020) have observed, tends to have a larger proportion of the population suffering from more than one chronic disease, consuming fewer cigarettes, and earning a higher than average gross annual salary. These three factors, as indicated by a multiple logistic regression analysis, include some of the HDI effects on the rates of infection and death. An explanation might be offered by these factors, at least in part, for the positive correlation noticed between HDI and the risk of COVID-19 infections and deaths in Italy (Liu et al., 2020). The correlation between HDI and COVID-19 illnesses and fatalities continues to show a moderately positive result. However, Western countries tend to inflate this correlation due to living conditions that permit more people to live to an elderly age. The only non-Western country of the 30 oldest countries in the world (i.e., having the highest percentage of residents over 65 years old) is Japan. This means that the primarily Western European countries are more vulnerable to COVID-19 due to their elderly demographic, which is disproportionately affected by this virus (Levin et al., 2020). After accounting for many area-level confounders, Wu et al. (2020) found a positive association between higher historical PM2.5 pollution exposures in the USA and higher COVID-19 mortality rates at the county level, with a slight increase in continuous exposure to PM2.5 leading to a greater increase in COVID-19 death rates. Their results highlight the point that sustained enforcement of existing air pollution regulations is one of essential efforts to protect human health both during the COVID-19 pandemic and beyond. Seeking to identify the influence of precipitation, temperature, and biodiversity, Fernández et al. (2021) applied spatio-temporal models with data from 160 countries. They also used count time series to describe the association between air quality factors and COVID-19 spread. Each analysis was adjusted for government policy intervention, country-income level, and sociodemographic confounders. Their results showed a statistically significant association between coronavirus cases and several country- and city-level factors of interest such as pollutants (PM10, PM2.5, and O3), air quality, and the national biodiversity index. These links provide valuable input to inform national environmental and health policies as an alternative response strategy to new COVID-19 waves and for the prevention of future crises. Bashir et al. (2020) looked for links between climate indicators and COVID-19 in New York City, USA, and discovered a significant association between the average temperature, the minimum temperature, air quality, and the spread of the COVID-19 pandemic. They noted that other meteorological indicators—humidity and air quality among them—also play a role. Humidity, for instance, contributed to the rapid spread of COVID-19 within New York City (Sajadi et al., 2020). Because air quality is important, Bashir et al. (2020) believe that green environmental policies should be promoted, as they would limit the spread of infectious diseases, including COVID-19.

Developed and developing countries can learn a great deal from one another in their struggles with COVID-19 (Anttiroiko, 2021). For example, East Asian people who adapted to wearing masks and social distancing as standard collective measures was a key reason that ensured their entire community's safety together (Liu et al., 2020). However, developing countries are likely to suffer heavier economic and human costs, because they generally have poorer governance, larger informal sectors, lower health care capacity, shallower financial markets, and less fiscal space (Loayza and Pennings, 2020). Likely impacts from the COVID-19 pandemic include increased extreme poverty rates in developing countries (World Bank, 2020), as well as aggravated political and social divisions and higher inequality (Furceri et al., 2020). It is also necessary to view developing countries by their health conditions (Derakhshandeh-Rishehri et al., 2014), water resource conditions (Ostad-Ali-Askari et al., 2017; Ostad-Ali-Askari and Shayannejad, 2021) and other local conditions. Scientists (Roper, 2020; Schell et al., 2020; Brauner et al., 2021) have analyzed the dynamic effects of the environment pertinent to the economy, culture, ecology, population density, health systems, local and state regulations, and other indicators regarding the scope of the pandemic. The revocation of people’s rights by the implementation of social restrictions, including lockdowns, intended

to slow the pandemic, have never been instituted in liberal democracies (Grogan, 2020). Social restrictions did demonstrate their effectiveness; unfortunately, however, mental health suffered throughout populations (Brülhart et al., 2021). Studies (Van Dorn et al., 2020; Wade, 2020; Ahmed, 2020) also investigated why the infection and mortality rates from COVID-19 are disproportionately high in communities of color in cities of the United States and United Kingdom. The proposal put forward as a result of the existing situation was to analyze alternative strategies and tactics for lessening the effects of COVID-19 (Bedford et al., 2020; Cohen and Kupferschmidt, 2020; Stockmaier et al., 2021).

The systemic analysis conducted for this research covered documents and scholarly literature from international institutions and intergovernmental organizations published during the COVID-19 period and up to one century earlier that included the Spanish Flu and HIV/AIDS pandemics. The studies involved had analyzed interdependencies influencing pandemic spreads and relevant country cultures. Interrelationships between country successes, sustainability, and COVID-19 indicators from different countries were also investigated. Some systemic reviews and meta-analyses designated for describing such research were also discovered. However, no studies were found that attempted to summarize the impact of country success across the scope of COVID-19 cumulative cases and excess deaths. Here, the studies conducted developed the CSC Map models and validated worldwide research results claiming interdependencies between the policy responses to COVID-19 enacted by countries and the indicators of a respective country's success and sustainability.

In this study, alternative cross-cultural theories, the spread of the pandemic, culture, and links between them and interrelationships between country success, sustainability, and COVID-19 indicators were analyzed. This interdisciplinary research integrates various domains into one study. It incorporates knowledge from numerous interconnected fields like medicine, society, culture, economy, politics, and the environment. All of these fields, which are examined in this research in an integrated manner, innovatively enlarge the big picture of COVID-19 pandemic on a global scale. This health policy research involved the development of Country Successes and a COVID-19 (CSC) Map of the World. The map, along with statistical calculations and CSC Map Models, serve as the basis for establishing conclusions. We suggest policy recommendations to improve the micro-, meso-, and macro-level environment during and post the COVID-19 period.

This research consists of foremost statements as presented here. It contains the integrated analysis on countries and their COVID-19 (CSC), which has augmented the information on such sciences globally. This is the first study to appear with an integrated analysis on country successes globally and their COVID-19 cumulative cases and excess deaths. New Country Success and the COVID-19 Map of the World was compiled over the course of this research. This map shows that, as the success of a country grows, cumulative cases increase; however, excess deaths from COVID-19 per 100,000 population decrease in parallel. By the same, it was established that micro-, meso- and macro-environments limit the pursuit of freedom by certain people under pandemic conditions. Four hypotheses were raised during the research and subsequently confirmed that the successes of countries around the world continue increasing over time. Meanwhile the numerous indicators describing such successes continue improving. Consequently many inhabitants turn greater and greater attention on needs involving freedom, liberty and autonomy.

### 3.2. METHOD

This study quantitatively assesses how country success impacted the 2020 spread of COVID-19 cumulative cases and excess deaths in 169 countries. Four fundamental hypotheses were suggested and confirmed for this research.

- The first hypothesis: The dimensions of country successes and COVID-19 can be applied to the existing eight clusters on the abscissa and ordinate axes of the 2020 Inglehart–Welzel Cultural Map of the World.

- The second hypothesis: The indicators in the system of criteria regarding country success and sustainability are interrelated. Thus, when the numbers of countries and their indicators change, the conditional successes of countries remain quite similar. Likewise, the seven clusters of countries under consideration group together independently of which system of indicators had been applied for their analysis.
- The third hypothesis: As the success of a country grows, cumulative cases increase, although excess deaths from COVID-19 per 100,000 population decreases in parallel.
- The fourth hypothesis: Micro-, meso-, and macro-environments limit people's pursuit of freedom under pandemic conditions

Data from the framework of variables that this research employed came from different databases and websites (the World Bank, Eurostat-OECD, Knoema, Global Data, the World Health Organization, Transparency International, statistics from the global and country economies, Freedom House, Global Finance, Heritage) as well as various publications.

This research optimises the functions by means of correlation analysis aimed at determining interrelationships linking macroeconomic, environmental, political, human development and well-being, values-based and quality of life indicators in various countries. In addition, the linear regression method is used to determine the combined impact of individual factors on the success and priority of specific countries. We also use the qualitative comparison method to compare our research findings with those by other authors. To calculate each country's success, priority, and degree of national competitiveness, we use the first five steps of the INVAR method (Figure 3.1).

The development of an integrated system of indicators comprises four steps:

- Countries have been grouped into clusters: based on the literature analysed with the aim to discover which countries belong to which cultural group, specific country clusters have been selected and each populated with relevant countries analysed in the research;
- Indicators have been selected: based on national sustainable development and success indicator systems presented by various authors, the indicators that are the most common in their studies and reflect national sustainable development and success, as well as the spread of the COVID-19 pandemic in individual countries, have been selected;
- Systems of indicators have been built: two systems of indicators ($CS_8$ and $CS_{15}$) have been built with indicators that best reflect national macroeconomic, environmental, political, human development and wellbeing, values-related and quality of life aspects;
- Data have been collected: indicator values have been collected for the research from various statistical databases and websites to be used in further analysis.

The Country Successes and COVID-19 (CSC) Map of the World covering COVID-19 cumulative cases and excess deaths was compiled for this research. The methods for this study include correlation and multiple criteria analyses. IBM SPSS V.26 was applied to complete multiple regressions to develop various regression models on COVID-19 and success in countries. Development of the CSC Map involved an analysis of 169 countries. Meanwhile the 2020 Inglehart–Welzel Cultural Map of the World includes 103 countries. This research validated four major proposed hypotheses.

This study proposes the Country Success and COVID-19 (CSC) Map of the World. Its development involved the use of two dimensions, one reflecting country success and the incidences of COVID-19. The INVAR method (Kaklauskas, 2016) was employed along with various sets of national success and sustainability indicators to measure the success of the 169 countries selected for this research. The CSC Map uses eight clusters (English-speaking, Protestant Europe, Catholic Europe, Orthodox Europe, Latin America, West and South Asia, Confucian and African-Islamic), as defined by the Inglehart–Welzel 2020 Cultural Map of the World (Inglehart, 2021). The INVAR method of multicriteria analysis was applied to various countries, for instance those in Asia (Kaklauskas, 2020) and in the former USSR (Kaklauskas et al., 2018). The Inglehart–Welzel 2020 Cultural Map of the World includes many psychological, institutional, technological, and economic variables that demonstrate strong correlations with each other (Fog, 2020).

The analyses contained within the dimension that is the Y-axis, pertinent to COVID-19, consist of cumulative cases (World Health Organization, 2021a) and COVID-19 excess deaths per 100,000 population (*The Economist*, 2021a). The dimension on the CSC Map pertinent to the success of countries can be defined as an entire array of variables within the system of macroeconomic, environmental, political, human development and well-being, values-based, and quality of life criteria. The presentation here pertains to a statistical comparison between 169 countries on the CSC Map and 103 countries on the Inglehart–Welzel 2020 Cultural Map of the World. It is quite complicated to envision 160 countries on one CSC Map, therefore the map is broken up into two parts—one displaying countries suffering up to 500 COVID-19 cumulative cases per 100,000 (Figure 3.5b) and over 500 cases respectively (Figure 3.5a).

The INVAR technique (Kaklauskas, 2016, Figure 3.1) assumes a straight and comparative dependency on country success, priority, and degree of national country competitiveness, from a system of indicators that defines countries with versatility by the weights and values of indicators under analysis. Stages 1–5 of the INVAR technique are identical to those for the COPRAS technique (Zavadskas, Kaklauskas, and Sarka, 1994).

The criteria constituting definitive evaluation measures are, first, set as a system for use in establishing country success. Then its units and criteria values as well as criteria weights are determined. Finally, the information obtained is tabulated for conducting a multiple criteria analysis and forming decision matrices. Various databases and websites (the World Bank, Eurostat-OECD, Knoema, Global Data, the World Health Organization, Transparency International, statistics from the global and country economies', Freedom House, Global Finance, Heritage, etc.) form the basis for the established values of these indicators. The weights of all the indicators under consideration are the same, and equal one. The foundation for determining the priority, success, and national competitiveness degree rankings of countries under consideration is the multiple criteria analysis decision matrix. Consideration of 169 countries was based on the performance of this multicriteria analysis. There were countries that were not included in this analysis due to the unavailability of their official comparable data.

The ranking pertinent to country success ($S_j$) by country priority ($P_j$) and by national competitiveness degree for the respective country ($N_j$) provides a thorough description of the results obtained from the respective country under consideration. The country success of each respective country is ranked by its priority. A more efficient and sustainable country displays a higher ranking with a higher $S_j$ value. The maximum success $S_{max}$ always establishes the country with the greatest efficiency and sustainability. Thereby, any value less than $S_{max}$ indicates the lesser success of that respective country. A comparison of a country to the country with the highest success constitutes the national competitiveness degree for that respective country. All national competitiveness degrees for considered countries $N_j$ will thus be between 0% (least success) and 100% (most success, $N_{max}$). The national competitiveness degree for some countries considered will be higher depending on the significance of that country's accomplished goals (Figure 3.1).

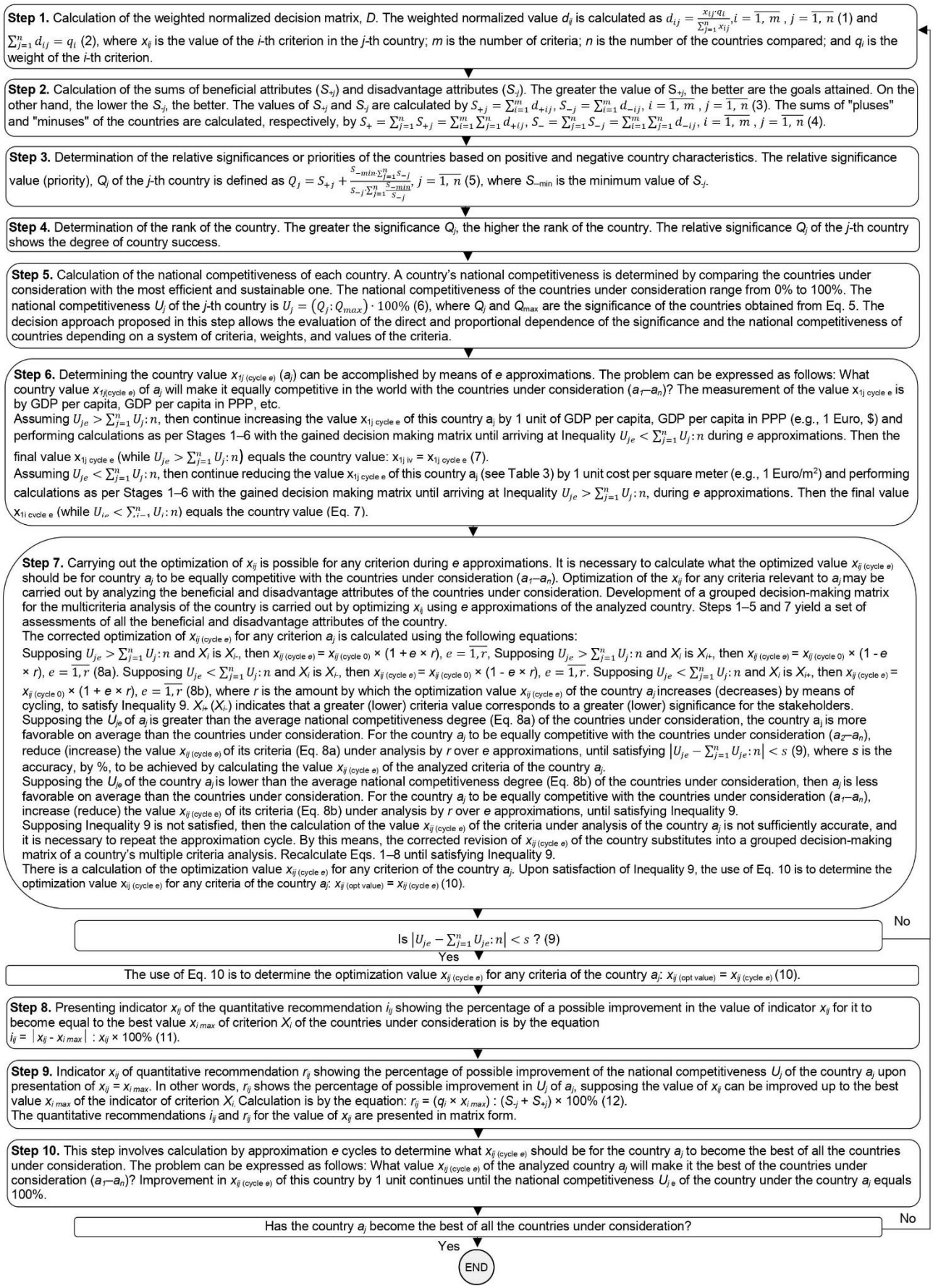



**Figure 3.1.** The structure of the INVAR method used for the multiple criteria analysis of 169 countries

Two clusters, English-speaking and Protestant Europe, were joined to become one due to their closely related common histories, cultural interactions, similar development levels, and religions. Numerous

studies (Haller, 2003) validated the similarities between the English-speaking and the Protestant European clusters.

The statistical validation of the CSC Map was confirmed in three directions after establishing the various statistically significant relationships between 15 variables, 169 countries and the dimensions of the Inglehart–Welzel 2020 Cultural Map of the World (hypotheses 1–4).

### 3.2.1. Details on the countries under discussion and their comprehensive indicator systems

To report country success, their efforts to mitigate the impact of COVID-19 and the relevant external environment as a whole in quantitative form, data that describe various aspects are presented. This quantitative information, which includes systems of criteria, measuring units, values and weights, is then used in our statistical and multiple criteria analysis.

The CSC Map was created (and their statistical analysis was undertaken) by looking at all 169 countries that have available data on cumulative cases (World Health Organization, 2021a) and excess deaths (*The Economist*, 2021a) per 100,000 of the population. The CSC Map uses eight clusters, as defined by the Inglehart–Welzel 2020 Cultural Map of the World (Inglehart, 2021). Two clusters from the World Value Survey (WVS) (Inglehart, 2021) were of culturally related countries, and these were comprised of the English-speaking and the Protestant European clusters, which were combined into one CSC Map cluster.

The CSC Map, multiple criteria, and correlation analyses illustrate the relationship between the success of 169 countries and their respective COVID-19 indicators. There are differences between different societies according two predominant dimensions: One is country success on the horizontal X-axis, and the other is the COVID-19 indicators on the vertical Y-axis. These two dimensions determine the location of a country on the CSC Map. Clusters of countries reflect their values in common, which are expressed by the indicators of country success and sustainability.

Furthermore, the various number of different countries can also be analyzed. The goal was to analyze a maximal number of countries with as many indicators as possible. This was not easy to perform, as many countries lacked one or more of the indicators. For example, several countries would be lost in the analysis whenever some indicator was missing. However, the problem of missing data was reduced in the following manner: A compromise was reached among the countries being considered and the number of indicators defining them. This study involved numerous systems of indicators describing countries under analysis in detail. An assessment of countries was accomplished by analyzing them by various aspects according to a system of 7, 8, 15, and 19 indicators.

The dimension of country successes on the CSC Map can be described in terms of an entire array of criteria pertinent to the sustainability and success of an aforementioned country. An effort was made to analyze a maximal number of countries in terms of as many indicators as possible. Several countries fell by the wayside, whenever one of the indicators was missing. A compromise had to be made pertinent to the countries under consideration and the number of indicators describing them. Finally, there were 169 countries examined according to a system of 15 descriptive criteria for this study. The CSC Map was analyzed during the course of this study by various cross-sections, which were required for the meaningfulness of the analysis due to the different numbers of countries.

Certainly, every country has its own specific history along with its predominant culture, traditions, religious, philosophical, and political views, for which additional indicators are required for a more accurate evaluation. The CSC Map does not include variables that would describe each country in much more detail for greater accuracy; thus the map is only approximately accurate. If such additional variables were available, it would be possible to evaluate much more accurately the governments of different countries along with the responses of their respective populations to the ever-fluctuating pandemic situation.

The studies performed by these authors, as well as other researchers, indicate the possibility of successfully performing numerous forecasts of sustainability indicators, because certain indicators in economics, politics, social, and environmental indicator groups usually correlate with one another.

Therefore, when compiling different models, there is usually little significance regarding which indicators are under analysis for determining the success and sustainability of a respective country.

A system of country success and sustainability indicators was compiled during this research based on global practices (Hueting and Reijnders, 2004; Van de Kerk and Manuel, 2008; Phillis et al., 2011; Moldan et al., 2012; Ren and Fang, 2016; Tan et al., 2017; Dias et al., 2017; Nilashi et al., 2019) and on the experience of these authors (Kaklauskas et al., 2018; Kaklauskas et al., 2020;). It consists of 15 macroeconomic, environmental, political, human development and well-being, values-based, and quality of life criteria from the year 2020.

A decision was made to equate the countries' single factor (superfactor) dimension on the X-axis of the CSC Map, based on the above analysis of alternative cross-cultural theories. For example, in this case, the country success dimension analyzes the following 15 indicators: GDP per capita ($V_1$), GDP per capita in PPP ($V_2$), ease of doing business ranking ($V_3$), the corruption perception index ($V_4$), the human development index ($V_5$), the global gender gap ($V_6$), the happiness index ($V_7$), the environmental performance index ($V_8$), freedom and control ($V_9$), economic freedom ($V_{10}$), the democracy index ($V_{11}$), unemployment rate ($V_{12}$), the economic growth forecast ($V_{13}$), the fragile state index ($V_{14}$), and economic decline index or healthy life expectancy ($V_{15}$). We examined two COVID-19 indicators (cumulative cases [$V_{16}$] and excess deaths [$V_{17}$] per 100,000 population) on the Y-axis of the CSC Map.

Data from the framework of variables that this research employed came from different databases and websites (the World Bank, Eurostat-OECD, Knoema, Global Data, the World Health Organization, Transparency International, statistics from the global and country economies, Freedom House, Global Finance, Heritage), as well as from various publications (Mundial, 2020; Wendling et al., 2020; World Health Organization, 2021; *The Economist*, 2021; Inglehart, 2021; Helliwell et al., 2021). The main difficulty was that a number of databases, websites, and publications lacked full data on all 169 countries under investigation, and covered only some of the data. Thus, the other aforementioned databases, websites, and publications were needed to compensate for any missing data. DigitizeIt software was applied to scan the survival versus self-expression and traditional versus secular-rational values data from the original 2020 Inglehart–Welzel Cultural Map of the World.

### 3.2.2. Validation of the first hypothesis: Statistical comparison of the CSC Map and the 2020 Inglehart–Welzel Cultural Map of the World

A single factor, found by Inglehart (2018), explains 81% of all cross-national variations. This single factor involves a combination of values: autonomy versus embeddedness, individualism versus collectivism, and survival versus self-expression (Fog, 2021). Welzel's (2013) criticism of the Inglehart–Welzel Cultural Map involves challenges to factor examination. In Welzel's (2013) opinion, the overall background of personal empowerment can combine secular and emancipatory values. A recalculation was performed on the data applied by Inglehart and Welzel for their study on this single factor. Derived from these findings, it was concluded that the single-factor solution was the more appropriate one (Li and Bond, 2010; Beugelsdijk and Welzel, 2018).

Some characteristics of cross-cultural variances, which correlate with one another, can be contained within a superfactor. There are several reasons for this. One reason is development, usually described in economic, technological, and institutional terms. Another reason involves cultural factors relevant to modernization. Yet another reason revolves around the regal versus kungic dimension description as a psychological factor. There is a significance to the numerous correlations of cultural variables within the superfactor (Fog, 2021). The superfactor that the Fog (2021) study identifies is a line that rotates differently from the lines that can be drawn on all of these maps.

The superfactor, which is the name for the strongest factor, contains over 50% of all cultural variables essential to contemporary cultures that correlate significantly with all obtainable, quantitative, and cross-cultural studies (Fog, 2021). The regality theory, a new concept based on evolutionary psychology, is the

basis for forecasting the existence of this superfactor. It encapsulates numerous important cultural phenomena that apparently correlate with one another. There are numerous reasons for this. One falls under the category of development, which encompasses physical and economic factors. Then there is modernization involving cultural values and institutions representing them. Additionally, there are social–psychological factors, which represent collectivism, regality, and tightness. Here, the variables are those like individualism versus collectivism, power and distance, egalitarian values, religiosity, tightness, regality, self-expression versus survival values, and secular-rational versus traditional values (Fog, 2021).

The predictions by Inglehart and Welzel (2005) are based on only a few variables, and no attempts are made to include numerous factors (many of them country-specific) that contribute to mass attitudes. Inglehart and Welzel (2005) believe a five-variable model that explains 75% of the variance is more efficient than a ten-variable model that explains 80%, and a model that explains as much variance as possible with as few variables as possible is thus their aim; the complexity of an explanation has to be smaller than that of reality in order to constitute a theory.

The research performed by these authors as well as other scholars, indicate that forecasting country success and sustainability can be successful by applying different economic, political, social, and environmental systems of indicators because these indicators correlate with one another. The detailed use of a single factor (superfactor) in the cross-national variation analysis appears next. The decision was to equate the single factor (superfactor) dimension of countries on the CSC Map with the X-axis, based on the above analysis of alternative cross-cultural theories. In this case, the country success dimension analyzes 7, 8, 15, and 19 indicators.

Pitifully, there are numerous reasons why the total number of pandemic-caused fatalities could be even higher. For one, some countries do not include victims in their official statistics when they do not show a positive test for coronavirus prior to death. Such victims could add up to the majority who died in this manner, in those places that have low testing abilities. Another reason may be an undercounting of deaths from diseases other than COVID-19. Doctors had a difficult time treating all needy patients, which probably kept many from seeking hospitalizations for different sorts of conditions, thereby eliminating these illnesses from the fatalities count. Therefore, an easier method, known as “Excess Deaths,” can be a means to overcome such methodological problems. This method counts all deaths from any illness or cause in a specific area over a specific period; following this, a comparison is made with a recent, historical baseline (*The Economist*, 2021a). The baselines developed by *The Economist* (2021a) applied statistical models to forecast the number of deaths a selected area would have experienced under more normal conditions during 2020 and 2021. Cumulative deaths per 100,000 population was not included in this analysis due to the reasons previously mentioned.

A correlation analysis was performed on the dimensions (the X and Y axes) of the CSC Map and the 2020 Inglehart–Welzel Cultural Map of the World. The basis for the analysis of 169 countries consisted of comprehensive write-ups on the 8 criteria system ($CS_8$) and the 15 criteria ($CS_{15}$) system, along with the indicators of their cumulative cases. As all the necessary data were not available for all countries, the calculation of the excess deaths indicator was based on data pertinent to 71 countries only. Meanwhile, the basis for the analyses on survival versus self-expression and traditional versus secular-rational values consisted of data from 99 countries (Table 3.1). Different resources often contain differing data on excess deaths per 100,000 population. Therefore countries were taken from only one resource (*The Economist*, 2021a), which contains 2020–2021 data. Only the countries from the Inglehart–Welzel 2020 Cultural Map of the World (Inglehart, 2021) were examined for the analysis of excess deaths per 100,000 population. There were 70 countries considered within these limitations. This analysis was performed by seeking to visually compare the Inglehart–Welzel World Cultural Map (2020) with the CSC Map.

**Table 3.1.** Correlation between the results pertinent to 169 or fewer countries analyzed in the CSC Map and the 2020 Inglehart–Welzel Cultural Map of the World dimensions, 2020

| | Country Success and COVID-19 (CSC) Map of the World dimensions | 2020 Inglehart–Welzel Cultural Map of the World dimensions |
|---|---|---|

| | X axis | | Y axis | | X axis | Y axis |
|---|---|---|---|---|---|---|
| | $CS_{15}$ | $CS_8$ | Cumulative cases per 100,000 population | Excess deaths per 100,000 population | Traditional vs secular-rational values | Traditional vs secular-rational values |
| $CS_{15}$ | 1 | | | | | |
| $CS_8$ | .985* | 1 | | | | |
| Cumulative cases per 100,000 population | .588** | .619** | 1 | | | |
| Excess deaths per 100,000 population | -.530** | -.523** | .323* | 1 | | |
| Traditional vs. secular-rational values | *.846** | .849** | .399** | -.454** | 1 | |
| Traditional vs. secular-rational values | .706** | .686** | .502** | -.349* | .570** | 1 |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Comparisons of correlations between dimensions were by 15 criteria ($CS_{15}$) for one and by 8 criteria ($CS_8$) for the other. Upon completion of the Shapiro–Wilk Test, it was established that the values of all variables were not distributed according to the normal law of distribution ($p<0.05$). The Spearman correlation coefficient was applied to assess the correlations among the variables. Table 3.1 displays the results of this correlation analysis. The performed correlation analysis leads to the conclusion that all the selected variables correlate statistically significantly ($p<0.05$) with one another. The weakest link was established between cumulative cases and excess deaths per 100,000 population ($r=.323$). A very strong ($r=.985$), positive and statistically significant ($p<.01$) relationship exists between country success $CS_8$ and country success $CS_{15}$. This indicates that the variables are closely interrelated, making it possible to exchange one for the other.

Nonetheless, out of the 77 countries under consideration that were taken from the 2020 Inglehart–Welzel Cultural Map of the World (Inglehart, 2021), only 51 submitted their data on COVID-19 excess deaths to *The Economist* (2021a).

The pertinent results of the correlation analysis were presented to the 77 countries from the 2020 Inglehart–Welzel Cultural Map of the World, or WVS 2021 (Table 3.2).

**Table 3.2.** Results of the correlations analyzed between dimensions of the CSC Map and the 2020 Inglehart–Welzel Cultural Map of the World on 77 countries, 2020

| | Country Success and COVID-19 (CSC) Map of the World dimensions | | | | 2020 Inglehart–Welzel Cultural Map of the World dimensions | |
|---|---|---|---|---|---|---|
| | X axis | | Y axis | | X axis | Y axis |
| | $CS_{15}$ | $CS_7$ | Cumulative cases per 100,000 population | Excess deaths per 100,000 population | Traditional vs secular–rational values | Traditional vs secular–rational values |
| $CS_{15}$ | 1 | | | | | |
| $CS_7$ | .920** | 1 | | | | |
| Cumulative cases per 100,000 population | .370** | .488** | 1 | | | |
| Excess deaths per 100,000 population | -.560** | -.550** | .280* | 1 | | |
| Traditional vs. secular–rational values | .800** | .858** | .377** | -.482** | 1 | |
| Traditional vs. secular–rational values | .692** | .720** | .472** | -0.275* | .603** | 1 |

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Further, a practical comparison was performed between the dimensions (axes) of the CSC Map and the 2020 Inglehart–Welzel Cultural Map of the World to determine if there were any correlations between them. The correlations calculated between all dimensions excepting excess deaths stemming from the analysis on 77 countries appear in Table 3.2. There were 51 countries involved in the correlations calculated pertinent to the excess deaths variable. There were 15 criteria ($CS1_5$) and 7 criteria ($CS_7$) used to compare the correlations between dimensions. The results obtained also substantiate the first hypothesis. Upon performance of the correlation analysis, it was established that strong, positive, and statistically significant relationships exist between $CS_{15}$ and $CS_7$ (r=.920, p<0.01), $CS_{15}$ and traditional versus secular-rational values (r=.800, p<0.01), $CS_7$ and traditional versus secular-rational values (r=.920, p<0.01), as well as between $CS_7$ and traditional versus secular-rational values (r=.720, p<0.01). Upon performance of the correlation analysis, it was established that there are positive and statistically significant relationships of average strength between cumulative cases and traditional versus secular-rational values (r=.472, p<0.01) and between cumulative cases and traditional versus secular-rational values (r=.377, p<0.01). Meanwhile a negative, weak and statistically significant relationship has been established between excess deaths and traditional vs secular-rational values (r=-.275, p<0.05). Relationships of average strength that are positive and statistically significant exist between $CS_{15}$ and cumulative cases (r=.370, p<0.01), $CS_7$ and cumulative cases (r=.488, p<0.01), cumulative cases and traditional vs secular-rational values (r=.472, p<0.01), traditional vs secular-rational values and traditional vs secular-rational values (r=.603, p<0.01). Negative and statistically significant relationships of average strength were established between $CS_{15}$ and excess deaths (r=-.560, p<0.01), $CS_7$ and excess deaths (r=-.550, p<0.01) and excess deaths and traditional vs secular-rational values (r=-.482, p<0.01). A weak, positive albeit statistically significant relationship was established between cumulative cases and excess deaths (r=.280, p<0.05). Meanwhile a negative, weak and statistically significant relationship was established between excess deaths and traditional vs secular-rational values (r=-.275, p<0.05) (Table 3.2).

*The medium and strong correlations between the dimensions of the CSC Map and the 2020 Inglehart–Welzel Cultural Map of the World validate* the first h*ypothesis.* Table 3.2 validates the first hypothesis which proposes that the classification of eight-country clusters pertinent to the Inglehart–Welzel Cultural Map of the World can be applied to indicate country successes and COVID-19 on the CSC Map. This is due to the correlation between the dimensions reflecting the selected countries from both models. It must be emphasized that the same countries sustainability and success groups of indicators are applied in these models, even though differing indicators are applied in these groups.

### 3.2.3. Validation of second hypothesis

The second hypothesis claims an interrelationship between indicators in the system of criteria on country success and sustainability. Consequently, there is a similarity between the conditional successes of countries, even when the numbers of countries and their indicators change. For this reason, there is generally little significance when compiling various models regarding which indicators are being analyzed to establish the country's successes.

The verification of the second research hypothesis comprises three steps:

- Correlation analysis has been performed: to determine the strength and significance of indicator interrelationships, the way indicators interrelate within the $CS_8$ and $CS_{15}$ systems built for this research has been identified by country and indicator;
- The distribution of correlation coefficient values has been analysed: the distribution of the correlation coefficient values relevant to the indicators selected for this research has been analysed in the country groups. This analysis has helped determine and show to what extent indicator values are interrelated within specific country groups;

- Dispersion analysis has been performed: this analysis has revealed the difference between the dispersions of the values of country success and priority indicators calculated by means of the INVAR method and the systems of indicators $CSP_8$ and $CSP_{15}$.

The dependence of country success and priority on the selected indicators has been verified using the following steps:

1. The distributions of the values of country success and priority variables have been compared: to validate the second hypothesis and determine which set of variables should be used in further analysis, the values of country success and priority variables calculated based on the systems of indicators $CS_8$ and $CS_{15}$ have been compared;
2. Linear regression CSC Map Models have been built: linear regression models have been built to show the dependence of country success and priority on the set of independent variables selected for our analysis;
3. The suitability of the linear regression CSC Map Models for analysis has been verified: the suitability of the models for analysis has been verified by calculating their statistical significance. Coefficients of determination have also been calculated to determine to what extent changes in the values of the independent variables explain the dispersions of the values of country success and priority variables;
4. The significance of the variables used in the models has been verified: the values of the coefficients of the independent variables in the linear regression models have been established and the statistical significance of the coefficients measured.

These steps have validated the second hypothesis and confirmed that both sets of variables can be used in further analysis.

#### 3.2.3.1. Cross-country correlation analysis of 169 countries

The endeavor to substantiate the second hypothesis involves a further, integrated, cross-country correlation analysis on 169 countries.

A correlation analysis was performed on 169 countries by eight indicators. It leads to the conclusion that the values of all the applied indicators correlate with one another. The correlations among all the variables show an average strength ($r>.3$) or a strong one ($r>.7$). It is also noteworthy that all the correlations are statistically significant ($p<.01$).

**Table 3.3.** Correlation coefficient values of 8 (a) and 15 (b) criteria under consideration characterizing 169 countries, 2020

a)

| | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ |
|---|---|---|---|---|---|---|---|---|
| $V_1$ | 1 | | | | | | | |
| $V_2$ | .675** | 1 | | | | | | |
| $V_3$ | .444** | .464** | 1 | | | | | |
| $V_4$ | .730** | .827** | .543** | 1 | | | | |
| $V_5$ | .559** | .605** | .382** | .598** | 1 | | | |
| $V_6$ | .548** | .634** | .254** | .681** | .650** | 1 | | |
| $V_7$ | .551** | .746** | .357** | .638** | .433** | .560** | 1 | |
| $V_8$ | -.729** | -.826** | -.433** | -.841** | -.713** | -.800** | -.678** | 1 |

$V_1$ - GDP per capita; $V_2$ - human development index; $V_3$ - happiness index; $V_4$ - environmental performance index;

$V_5$ - economic freedom; $V_6$ - democracy index; $V_7$ - healthy life expectancy; $V_8$ - fragile state index

** Correlation is significant at the 0.01 level (2-tailed).

b)

| | $V_1$ | $V_2$ | $V_3$ | $V_4$ | $V_5$ | $V_6$ | $V_7$ | $V_8$ | $V_9$ | $V_{10}$ | $V_{11}$ | $V_{12}$ | $V_{13}$ | $V_{14}$ | $V_{15}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_1$ | 1 | | | | | | | | | | | | | | |
| $V_2$ | .940** | 1 | | | | | | | | | | | | | |
| $V_3$ | -.572** | -.652** | 1 | | | | | | | | | | | | |
| $V_4$ | .770** | .765** | -.700** | 1 | | | | | | | | | | | |
| $V_5$ | .675** | .775** | -.763** | .715** | 1 | | | | | | | | | | |
| $V_6$ | .417** | .375** | -.442** | .513** | .416** | 1 | | | | | | | | | |
| $V_7$ | .444** | .487** | -.520** | .309** | .464** | .299** | 1 | | | | | | | | |
| $V_8$ | .730** | .768** | -.690** | .739** | .827** | .505** | .543** | 1 | | | | | | | |
| $V_9$ | -.477** | -.458** | .452** | -.677** | -.563** | -.530** | -.108 | -.608** | 1 | | | | | | |
| $V_{10}$ | .559** | .603** | -.715** | .761** | .605** | .420** | .382** | .598** | -.456** | 1 | | | | | |
| $V_{11}$ | .548** | .530** | -.565** | .760** | .634** | .600** | .254** | .681** | -.891** | .650** | 1 | | | | |
| $V_{12}$ | -.161* | -.126 | .087 | -.055 | -.006 | -.028 | -.143 | .01 | -.041 | -.062 | .042 | 1 | | | |
| $V_{13}$ | .551** | .593** | -.540** | .620** | .746** | .378** | .057 | .638** | -.552** | .433** | .560** | -.017 | 1 | | |
| $V_{14}$ | -.729** | -.783** | .719** | -.856** | -.826** | -.588** | -.433** | -.841** | .741** | -.713** | -.800** | .047 | -.678** | 1 | |
| $V_{15}$ | -.652** | -.738** | .681** | -.726** | -.769** | -.442** | -.478** | -.726** | .502** | -.718** | -.655** | .240** | -.596** | .846** | 1 |

$V_1$ - GDP per capita; $V_2$ - GDP per capita in PPP; $V_3$ - ease of doing business ranking; $V_4$ - corruption perceptions index; $V_5$ - human development index; $V_6$ - global gender gap; $V_7$ - happiness index; $V_8$ - environmental performance index; $V_9$ - freedom and control; $V_{10}$ - economic freedom; $V_{11}$ - democracy index; $V_{12}$ - unemployment rate; $V_{13}$ - healthy life expectancy; $V_{14}$ - fragile state index; $V_{15}$ - economic decline index

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The correlation analysis performed on 169 countries pertinent to the 15 success and sustainability criteria leads to the conclusion that all the criteria correlate statistically and significantly with one another. The only exception is the unemployment rate criterion, which only correlates with GDP per capita ($r=-.161$, $p<0.05$) and with the economic decline index ($r=-.240$, $p<0.01$). The correlation with other criteria under study, such as the unemployment rate, are statistically insignificant. The strongest, positive correlation was established between the GDP per capita and the GDP per capita in PPP criteria ($r=.940$, $p<0.01$). The strongest negative link was established between the corruption perception index and the fragile state index ($r=-.856$, $p<0.01$) (Table 3.3b). The conclusion that can be drawn is that—independently of the numbers of variables used for the study—all the applied variables correlate with one another at statistically significant rates.

Fragments of the correlation coefficient matrix pertinent to the 8 and 15 criteria for each of the 169 countries appear in Table 3.4.

**Table 3.4.** Correlation coefficient matrix fragment of 8 (a) and 15 (b) criteria for 169 countries

a) see http://176.223.140.136/correlations/

| | Algeria | Argentina | Armenia | Australia | Austria | Azerbaijan | Bangladesh | Belgium | Brazil | Bulgaria | Chile | China | Colombia | Croatia | Czech Repu | Denmark | Ecuador | Estonia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Algeria | 1 | | | | | | | | | | | | | | | | | |
| Argentina | .99985 | 1 | | | | | | | | | | | | | | | | |
| Armenia | .99996 | .99993 | 1 | | | | | | | | | | | | | | | |
| Australia | .99972 | .99997 | .99983 | 1 | | | | | | | | | | | | | | |
| Austria | .99972 | .99998 | .99983 | 1 | 1 | | | | | | | | | | | | | |
| Azerbaijan | .99997 | .99992 | 1 | .99981 | .99981 | 1 | | | | | | | | | | | | |
| Bangladesh | .99975 | .99925 | .99959 | .99900 | .99900 | .99964 | 1 | | | | | | | | | | | |
| Belgium | .99972 | .99998 | .99983 | 1 | 1 | .99981 | .99900 | 1 | | | | | | | | | | |
| Brazil | .99992 | .99999 | .99996 | .99994 | .99994 | .99996 | .99941 | .99994 | 1 | | | | | | | | | |
| Bulgaria | .99984 | 1 | .99993 | .99998 | .99998 | .99991 | .99923 | .99998 | .99999 | 1 | | | | | | | | |
| Chile | .99980 | 1 | .99990 | .99999 | .99999 | .99988 | .99916 | .99999 | .99997 | 1 | 1 | | | | | | | |
| China | .99985 | .99999 | .99992 | .99998 | .99998 | .99992 | .99928 | .99998 | .99999 | .99999 | .99999 | 1 | | | | | | |
| Colombia | .99996 | .99996 | .99999 | .99988 | .99988 | .99999 | .99954 | .99988 | .99999 | .99996 | .99994 | .99996 | 1 | | | | | |
| Croatia | .99980 | 1 | .99989 | .99999 | .99999 | .99988 | .99915 | .99999 | .99998 | 1 | 1 | .99999 | .99993 | 1 | | | | |
| Czech Repu | .99976 | .99999 | .99986 | 1 | 1 | .99984 | .99906 | 1 | .99996 | .99999 | 1 | .99999 | .99991 | 1 | 1 | | | |
| Denmark | .99971 | .99997 | .99982 | 1 | 1 | .99981 | .99899 | 1 | .99994 | .99998 | .99999 | .99997 | .99988 | .99999 | 1 | 1 | | |
| Ecuador | .99994 | .99998 | .99997 | .99991 | .99991 | .99997 | .99947 | .99992 | 1 | .99997 | .99996 | .99998 | .99999 | .99996 | .99993 | .9999 | 1 | |
| Estonia | .99976 | .99999 | .99986 | 1 | 1 | .99984 | .99907 | 1 | .99996 | .99999 | 1 | .99999 | .99991 | 1 | 1 | 1 | .99993 | 1 |
| Finland | .99972 | .99997 | .99983 | 1 | 1 | .99981 | .99899 | 1 | .99994 | .99998 | .99999 | .99998 | .99988 | .99999 | 1 | 1 | .99991 | 1 |
| France | .99973 | .99998 | .99983 | 1 | 1 | .99982 | .99901 | 1 | .99995 | .99998 | .99999 | .99998 | .99989 | .99999 | 1 | 1 | .99992 | 1 |
| Germany | .99972 | .99998 | .99983 | 1 | 1 | .99981 | .99900 | 1 | .99994 | .99998 | .99999 | .99998 | .99988 | .99999 | 1 | 1 | .99991 | 1 |

b) see http://176.223.140.136/8criteria/

| | Algeria | Argentina | Armenia | Australia | Austria | Azerbaijan | Bangladesh | Belgium | Brazil | Bulgaria | Chile | China | Colombia | Croatia | Czech Repu | Denmark | Ecuador | Estonia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Algeria | 1 | | | | | | | | | | | | | | | | | |
| Argentina | .9944 | 1 | | | | | | | | | | | | | | | | |
| Armenia | .9996 | .9968 | 1 | | | | | | | | | | | | | | | |
| Australia | .8652 | .9134 | .8783 | 1 | | | | | | | | | | | | | | |
| Austria | .8961 | .9381 | .9077 | .9979 | 1 | | | | | | | | | | | | | |
| Azerbaijan | .9999 | .9942 | .9996 | .8646 | .8956 | 1 | | | | | | | | | | | | |
| Bangladesh | .9962 | .9994 | .9979 | .9045 | .9303 | .9958 | 1 | | | | | | | | | | | |
| Belgium | .9001 | .9412 | .9115 | .9972 | 1 | .8997 | .9337 | 1 | | | | | | | | | | |
| Brazil | .9885 | .9990 | .9922 | .9310 | .9528 | .9883 | .9975 | .9556 | 1 | | | | | | | | | |
| Bulgaria | .9940 | 1 | .9966 | .9146 | .9391 | .9939 | .9993 | .9422 | .9991 | 1 | | | | | | | | |
| Chile | .9777 | .9944 | .9830 | .9512 | .9693 | .9775 | .9916 | .9715 | .9982 | .9947 | 1 | | | | | | | |
| China | .9624 | .9858 | .9694 | .9688 | .9829 | .9622 | .9817 | .9846 | .9924 | .9863 | .9980 | 1 | | | | | | |
| Colombia | .9976 | .9993 | .9991 | .8976 | .9245 | .9975 | .9995 | .9280 | .9966 | .9992 | .9898 | .9789 | 1 | | | | | |
| Croatia | .9846 | .9976 | .9889 | .9395 | .9599 | .9844 | .9955 | .9624 | .9997 | .9978 | .9994 | .9951 | .9943 | 1 | | | | |
| Czech Repu | .9745 | .9928 | .9802 | .9556 | .9728 | .9743 | .9896 | .9749 | .9972 | .9931 | .9999 | .9988 | .9876 | .9987 | 1 | | | |
| Denmark | .8592 | .9086 | .8726 | .9999 | .9970 | .8586 | .8994 | .9963 | .9266 | .9097 | .9475 | .9658 | .8924 | .9354 | .9521 | 1 | | |
| Ecuador | .9802 | .9957 | .9852 | .9473 | .9662 | .9800 | .9933 | .9685 | .9989 | .9959 | .9999 | .9971 | .9915 | .9997 | .9996 | .9434 | 1 | |
| Estonia | .9622 | .9857 | .9692 | .9690 | .9831 | .9620 | .9815 | .9847 | .9923 | .9862 | .9979 | 1 | .9787 | .9950 | .9988 | .9660 | .9970 | 1,0 |
| Finland | .8724 | .9193 | .8853 | .9999 | .9987 | .8719 | .9106 | .9982 | .9362 | .9204 | .9556 | .9723 | .9040 | .9444 | .9598 | .9996 | .9519 | .9725 |
| France | .9062 | .9459 | .9172 | .9961 | .9997 | .9057 | .9386 | .9999 | .9597 | .9468 | .9748 | .9869 | .9332 | .9662 | .9780 | .9950 | .9719 | .9871 |
| Germany | .9019 | .9426 | .9132 | .9969 | .9999 | .9014 | .9351 | 1 | .9568 | .9435 | .9725 | .9853 | .9295 | .9635 | .9758 | .9959 | .9695 | .9854 |

A distribution of correlation coefficients on the CSC Map was performed for 15 indicators by 169 countries. It can be surmised that the correlation coefficients of the selected country indicators are strong, because the overall median of all correlation coefficients is greater than 0.9. A possible presumption is that the developments of the 169 countries, selected for this study, are interrelated. This is indicated by the strong correlation of the development indicators for these countries (Figure 3.2). The interrelationship between worldwide indicators can explain this.

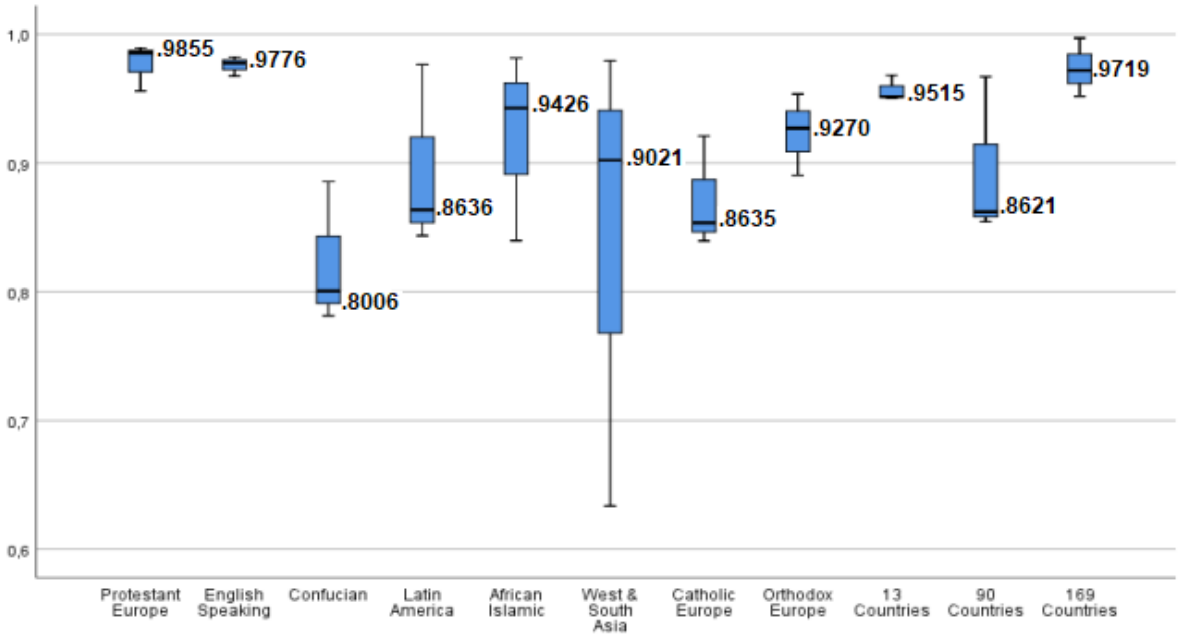



**Figure 3.2.** Distribution of correlation coefficients among 15 indicators by 169 countries on the CSC Map

Next, a correlation analysis was performed by an integrated examination of 77 countries. The 19 success and sustainability indicators involved in this required analysis would cover these 77 countries. These country success and sustainability indicators under consideration ($V_1$–$V_{15}$) definitely do not reflect all indicators pertinent to the dimensions of a country success and sustainability and, possibly, not even any fundamental ones. An examination of 77 control group countries from the 2020 Inglehart–Welzel Cultural Map of the World (Inglehart, 2021) in addition to 13 more experimental group countries, involved the 19 indicators that were named previously. A multiple criteria analysis matrix of the 19 criteria describing the 90 countries was created. Its data served as input to determine the correlation coefficients for each country and create a correlation matrix. The present analysis looked at the median values of the

correlation coefficients for each cluster of countries as a better way to represent the center-point in the rank orders of the correlation coefficients (Figure 3.2).

Using minimal median values of .80 pertinent to country criteria correlation coefficients revealed strong correlations between 19 criteria in each cultural cluster of the 90 countries included in the study. The highest median values have been determined in the Protestant European and English-speaking cluster at .986 (.956; .980; .998) and .978 (.932; .966; .982), respectively. Another important aspect is a very narrow spread of the values of the country criteria correlation coefficients in these regions. The highest spread of the correlation coefficients is in the West and South Asia cluster, with the median value at .902 (.101; .769; .994). Presumably, this spread is the result of a greater variation in the economic, social, cultural, environmental, and COVID-19 development levels of the region's countries. The regression coefficients pertinent to the 13 selected experimental group countries have a median that is also over 0.8. According to the applied indicators, this is the same as the median of the regression coefficients among the 90 countries, which were selected in common for this study. The development of the 77 control group countries included in the CSC Map grouped into the eight clusters defined in the Inglehart–Welzel 2020 Cultural Map of the World (Inglehart, 2021) is thus interrelated, as is evident from the strong correlation between the 19 economic, social, cultural, environmental, and COVID-19 cumulative cases per 100,000 population defining the countries grouped into the clusters. The same clustering of countries works well both in the CSC Map and the Inglehart–Welzel 2020 Cultural Map of the World, because the country criteria correlate between the countries in both models. Similar success and sustainability groups of criteria (except COVID-19 cumulative cases) applied to both of the maps employed, which would be important, except that the criteria of each group differ.

The values of the correlation coefficients and the statistical significance of their relationships suggest that all the criteria added to the country groups influence each other.

Thus, an interrelationship of the criteria pertinent to the success and sustainability indicators of countries verifies the second hypothesis. Additionally, as the numbers of countries and their indicators change, the conditional successes of countries remain quite similar.

#### 3.2.3.2. A Comparison of 169 countries' successes and priorities calculated by 8 and 15 criteria

The success and priority of the 169 countries shown on the X-axis and analysed in this chapter depend, directly and proportionally, on the system of adequate criteria that describe the countries, also on the criteria values and criteria weights. The first five steps of the INVAR method (Figure 3.1) were used to calculate the success and priority of each country.

In the endeavor to validate the second hypothesis, the calculations pertinent to the comparison of the successes and priorities of 169 countries were based on 8 and 15 criteria. Upon comparing the calculations pertinent to the success of 169 countries (CS) by 8 criteria ($CS_8$) and by 15 criteria ($CS_{15}$), the average absolute deviance established was 4.97%. The difference established between $CS_8$ and $CS_{15}$ does not exceed 5% for 111 of 169 countries, or 66.5% of them. The difference in the success of the remaining 33.5% of the countries is greater than 5%. However, it does not exceed 12.3%, which is indicated by the high degree of overlap between $CS_8$ and $CS_{15}$ (Figure 3.3).

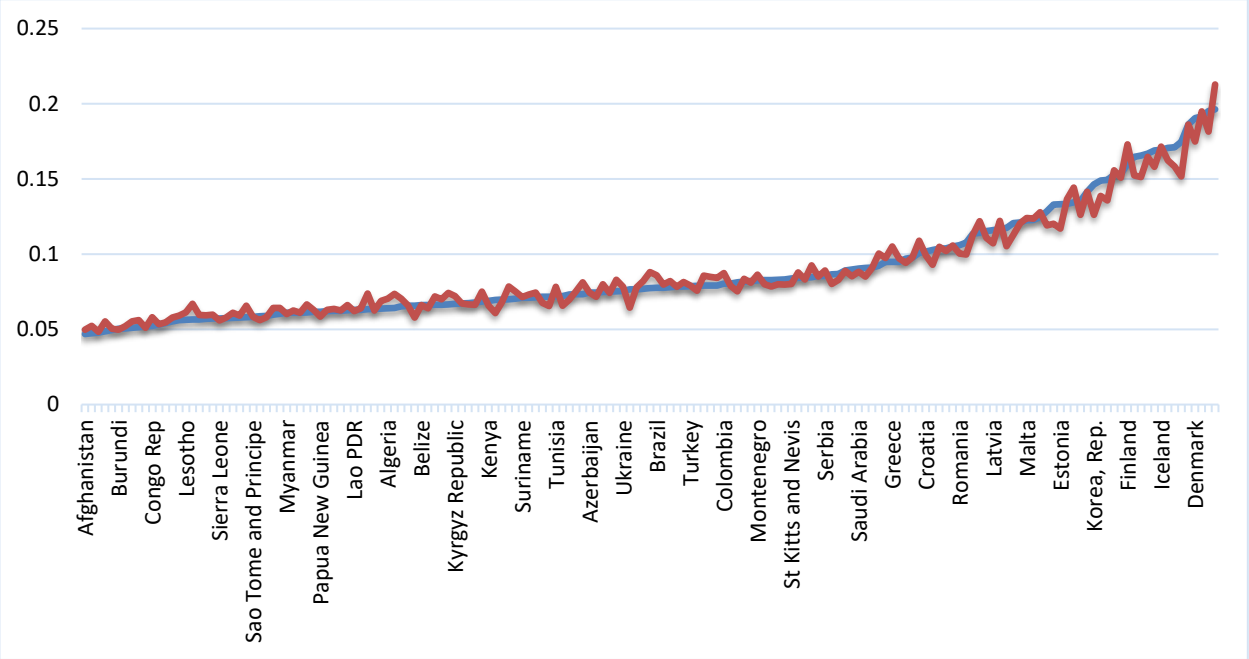



**Figure 3.3.** Country success comparison of 169 countries (calculated by 8 and 15 criteria)

- Country success calculated by 15 criteria ($CS_{15}$) for 169 countries

- Country success calculated by 8 criteria ($CS_8$) for 169 countries

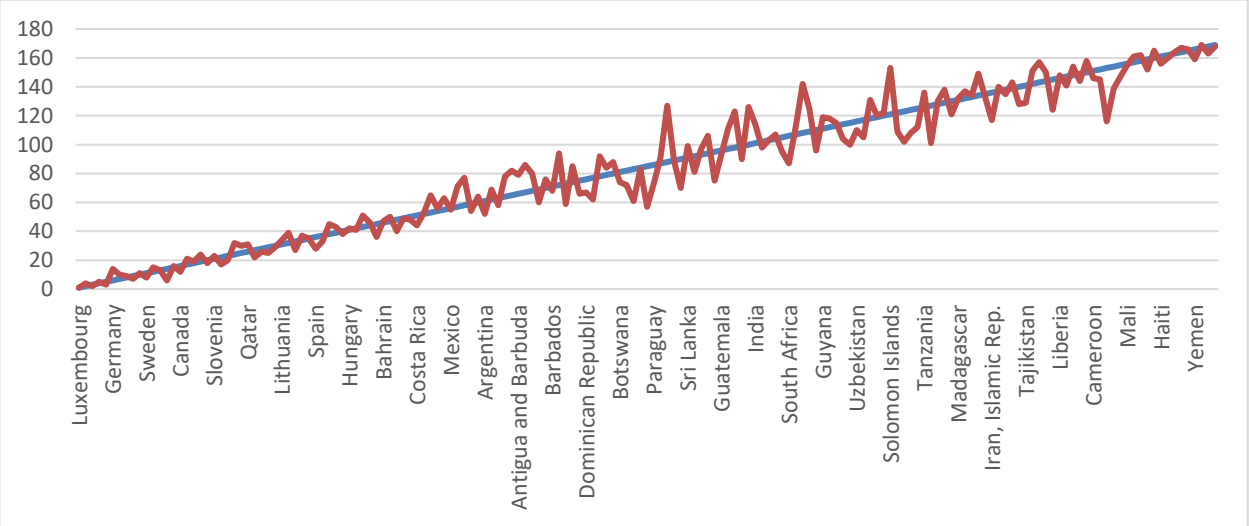



**Figure 3.4.** Priority comparison of 169 country successes (calculated by 8 and 15 criteria)

- Country success priorities calculated by 15 criteria ($CSP_{15}$) for 169 countries

- Country success priorities calculated by 8 criteria ($CSP_8$) for 169 countries

It is noticeable that the values of country success priorities calculated according to 8 criteria ($CSP_8$) are not very far from the values of country success priorities calculated according to 15 criteria ($CSP_{15}$). The deviation between the $CSP_8$ and $CSP_8$ values is 4.81%. It was also established that the difference between the values of $CSP_8$ and $CSP_{15}$ was less than 5% in 129 of 169 countries or in 77.2% of them. The difference was greater than 5%, albeit less than 15% for all the other countries, which indicates a sufficiently high correspondence between the values of $CSP_8$ and $CSP_8$ (Figure 3.4).

### 3.2.3.3. CSC Map Models

CSC Map Models evaluate the relationships between a dependent variable (country success or cumulative cases and excess deaths per 100,000 population) and 15 independent variables (the country success and sustainability indicators). CSC Map Models formally represent the CSC Map.

The 169-country CSC Map Model suggests that a 1% increase in the values of GDP per capita, the human development index, the global gender gap, the environmental performance index, and the democracy index causes corresponding increases in cumulative cases per 100,000 population by 0.38, 3.45, 3.57, 2.15, and 1.25%, respectively. According to the 78-country CSC Map Model, a 1% increase in the values of GDP per capita, the human development index, the global gender gap, the environmental performance index, and the democracy index causes corresponding decreases in excess deaths per 100,000 population by 0.52, 3.79, 1.76, 1.32, and 1.03%, respectively.

The countries being considered were divided up into a control group and an experimental group. The control group consisted of 77 countries corresponding to the countries employed by the 2020 Inglehart–Welzel Cultural Map of the World. The experimental group consisting of 64 countries was not analyzed by this map. The basis of these analyses of 64 and then 77 countries was the 15 criteria system ($V_1$–$V_{15}$). The countries are distributed across the CSC Map according to the values found on the X-axis (country success) and the Y-axis (COVID-19 indicators).

We applied the linear multivariable regression method to determine the influence of the selected criteria on the dispersion of the independent variables.

It was established that GDP per capita explains 80% of the dispersion of the 77 countries' success variable. Thus, the conclusion can be drawn that economic factors have the greatest influence on the dissemination of the success variable of 77 countries. This was not surprising, as various investigations indicate a huge continuum of influence from the GDP indicator. Considerable inertia is characteristic of gradually changing variables, such as socioeconomic development. At any point the stocks accumulated so far are always much greater than the gains achieved, or losses incurred in one year. GDP added in a year is always just a small percentage of the entire GDP of a country. Substantial changes in gradually changing, or accumulating, variables like these only become visible in the long run (Inglehart and Welzel, 2005). GDP per capita along with an economic growth forecast explain 81.2% of the dispersion of the country success variable. The fragile state index variable separately explains 72.1% of the dispersion of the country success variable, of its own accord. It was established, during the course of the study that the compiled model is suitable for deliberation ($p<.05$). Meanwhile all the variables used in the model explain 95.5% of the dispersion of the country success variable. The following is an analytical expression of the compiled model:

$$\mathrm{V_{CS}} = .164 + .001 \cdot \mathrm{V01} + .0003 \cdot \mathrm{V02} + .00003 \cdot \mathrm{V03} + .0004 \cdot \mathrm{V04} - .054 \cdot \mathrm{V05} + .031 \cdot \mathrm{V06} - .003 \cdot \mathrm{V07} + .001 \cdot \quad \cdot \mathrm{V08} - .002 \cdot \mathrm{V09} - .0002 \cdot \mathrm{V10} + .002 \cdot \mathrm{V11} - .001 \cdot \mathrm{V12} + .002 \cdot \mathrm{V13} - .0003 \cdot \mathrm{V14} - .004 \cdot \mathrm{V15} \quad (1)$$

The conclusion drawn upon completing the analysis of the model is that the greatest influence on the success variable of 77 countries comes from GDP per capita, the corruption perception index, the unemployment rate, and the fragile state index. This means that the variables in the system influencing country success consist of the macroeconomic, environmental, political, human development and well-being, values-based and quality of life criteria.

Although GDP per capita explains the country success variable quite suitably, in this case, it only explains 17.2% of the cumulative cases per 100,000 population ($V_{17}$) variable in the dispersion of 77 countries. Additional variables are needed when aiming to increase the explanatory power of the regression model. One such variable is freedom and control, which, separately from the rest, explains 34.2% of the dispersion in $V_{17}$. Of its own accord, though together with GDP per capita, freedom and

control explains 35.2% of the dispersion in $V_{17}$. Based on such regression analysis results, the conclusion can be drawn that it is necessary to include more country success and sustainability indicators in the model being considered. This would permit an increase in the explanatory power of the compiled model. By selecting the system containing macroeconomic, environmental, political, human development and well-being, and values-based and quality of life criteria, and completing the regression analysis, it becomes possible to draw a conclusion that the model is suitable for deliberation ($p<.05$). Meanwhile, all the selected variables explain 63.2% of the dispersion of the cumulative cases per 100,000 population variable. The regression equation compiled based on the results of the regression analysis is the following:

$$\mathrm{V17} = -4434.8 - 31.247 \cdot \mathrm{V01} + 50.177 \cdot \mathrm{V02} + 7.459 \cdot \mathrm{V04} + 6300.053 \cdot \mathrm{V05} + 5172.697 \cdot \mathrm{V06} + 322.084 \cdot \cdot \mathrm{V07} + 92.314 \cdot \mathrm{V08} - 2229.705 \cdot \mathrm{V09} + 32.145 \cdot \mathrm{V10} - 1527.857 \cdot \mathrm{V11} + 77.965 \cdot \mathrm{V12} + 73.835 \cdot \mathrm{V13} + 112.949 \cdot \cdot \mathrm{V14} - 245.591 \cdot \mathrm{V15} \quad (2)$$

A significant influence on the dependent, cumulative cases per 100,000 population variable in 77 countries comes from independent variables such as freedom and control, and the democracy and fragile state indices. The other independent variables have some influence on the dependent cumulative cases per 100,000 population variable; however, their influence is insignificant. Furthermore, it was established that the variables used for the seven separate country clusters applied on the CSC Map explain from 39.4% (for the West and South Asia region) to 76.3% (for the Protestant European region) of the dispersion of the cumulative cases per 100,000 population variable.

The model compiled on the success of 64 countries is suitable for consideration ($p<.05$). Furthermore, it was established that all the variables in the models being analyzed, which reflect the changes in the selected indicators, explain 97.2% of the dispersion of the country success variable. GDP per capita had the greatest influence on the country success variable. The changes in its value separately explain 73.5% of the dispersion of the country success variable. Additionally, the variable fragile state index has a significant influence on the country success variable. The changes in this variable explain 57.4% of the dispersion of the country success variable. Meanwhile the changes of both these variables explain 76.6% of the dispersion of the country success variable. Separately, changes in the economic decline index variable explain 47.7% of the dispersion of the country success variable. A conclusion can be drawn that GDP per capita, the fragile state index, and economic decline index variables have the greatest influence on the country success variable for the 64 countries under analysis. Changes in the values of these variables explain 78.5% of the dispersion in the country success variable. The other variable used in the model also influences the country success variable. However, its influence is not as great as that of the aforementioned variables.

Upon examining the dependence of the cumulative cases per 100,000 population variable ($V_{17}$) on the country success and sustainability indicators that have been used to assess 64 countries, it was established that this model is suitable for analysis. Meanwhile the changes in the values of the applied indicators explain 64.8% of the dispersion pertinent to the $V_{17}$ variable. The human development index variable has the greatest influence on the $V_{17}$ variable in the model. Separately, it explains 35.8% of the dispersion of the $V_{17}$ variable. Furthermore, the fragile state index variable also greatly influences the compiled model. Its changes explain 28.9% of the dispersion of variable $V_{17}$. Together these variables explain 36.6% of the $V_{17}$ dispersion. Changes in the values of the economic decline index variable separately explain 23.9% of the variable $V_{17}$ dispersion. Thus, a conclusion can be drawn that the human development index, fragile state index, and economic decline index variables have the greatest influence on the cumulative cases per 100,000 population variable ($V_{17}$). Together the changes under assessment explain 38.7% of the $V_{17}$ dispersion.

Next, the variable excess deaths per 100,000 population dispersion was analyzed against the 15-indicator CSC Map Model of 78 countries. The correlation analysis only used data on 84 countries pertinent to COVID-19 excess deaths per 100,000 population sourced from *The Economist* (2021a). The necessary 15 indicators under deliberation were not all available for six of the 84 countries that were submitted. Thus, only 78 countries were considered for this study. A conclusion is possible following the analysis on the dependency of excess deaths per 100,000 population from the model of 15 selected variables pertinent to the model of 78 countries. The model of the CSC Map is statistically significant ($p<.05$). Meanwhile changes in the values of the selected 15 criteria, accordingly, explain 52.8% pertinent to the dispersion of the excess deaths variable.

Other researchers have also obtained similar results relevant to the use of different numbers of variables (Inglehart, 1997; Inglehart and Welzel, 2005). The correlation is high between the factor scores from the 10 items under this analysis and the factor scores that are based on 22 items (Inglehart, 1997). The five items applied for this study as a basis pertinent to the traditional dimension versus the secular-rational dimension correlate nearly entirely with the factor scores from the dimension under comparison based on 11 variables ($r = .95$). Additionally, the survival versus self-expression dimension based on five variables also correlates nearly entirely with the survival versus self-expression dimension based on 11 variables ($r = .96$). These robust dimensions reflect a pool of many more items. There were technical reasons for applying five indicators to tap each dimension for a total of ten indicators that appear here (Inglehart and Welzel, 2005).

The second hypothesis is verified by this method, and there is an interrelationship between the indicators from the system of criteria, which thoroughly describe a country's success and sustainability. Additionally, as the numbers of countries and their indicators change, the conditional successes of countries remain quite similar.

### 3.2.4. Country Success and the COVID-19 Map of the World

The indicators' system, values, and significances equivalently influence the success and priority of the states presented on the axis of abscissas. We applied the initial five stages of the INVAR technique (Figure 3.1) to compute the success and priority of each state. The analyses contained within the dimension that is the Y-axis, pertinent to COVID-19, consist of cumulative cases (World Health Organization, 2021a) and COVID-19 excess deaths per 100,000 population (*The Economist*, 2021a).

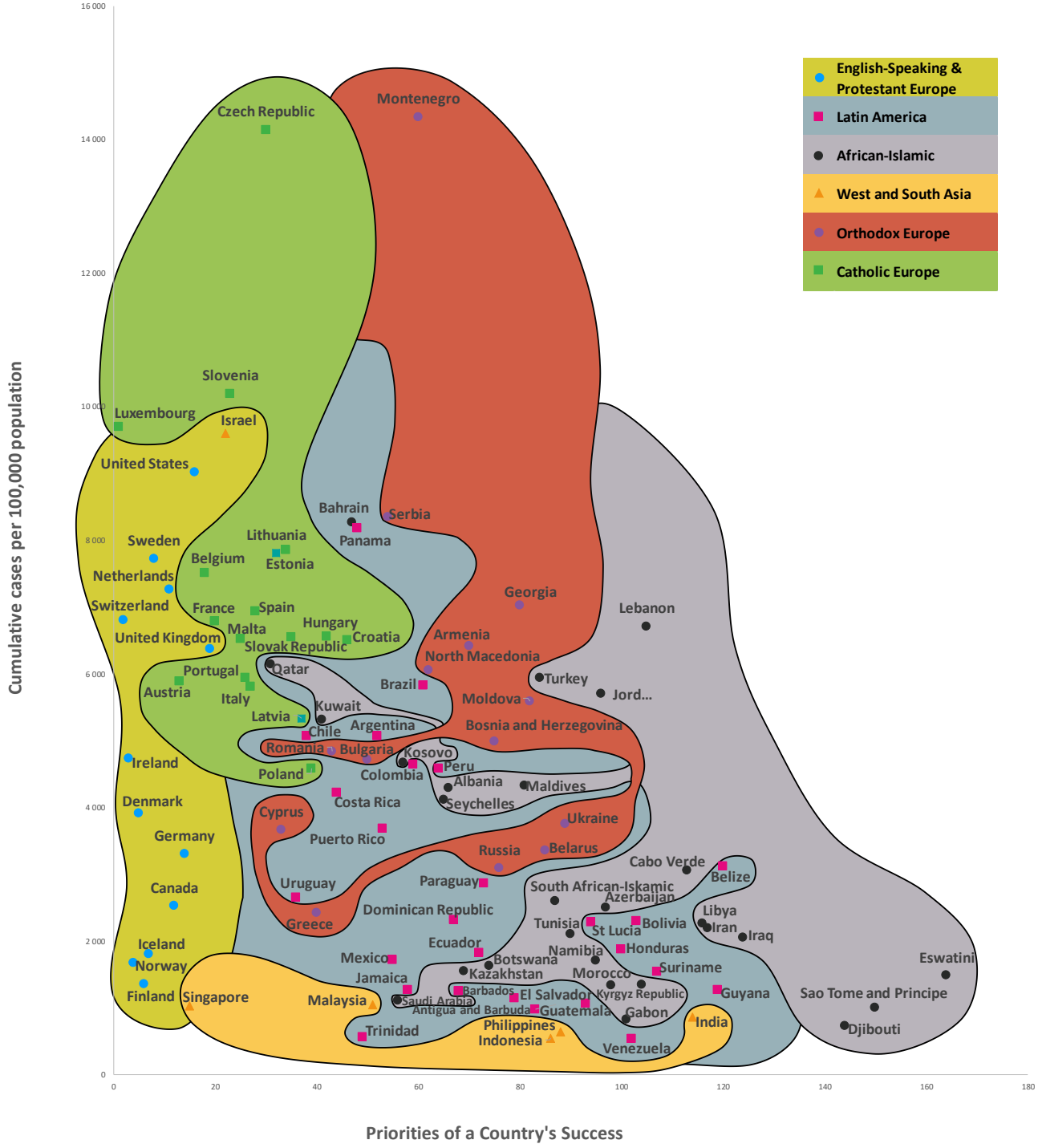
The development of Country Successes and COVID-19 Map of the World (CSC Map) was in two parts:

- Country Success and COVID-19 Cumulative Cases World Map (Figure 3.5)
- Country Success and COVID-19 Excess Deaths World Map (Figure 3.6)

This is a CSC Map displaying priorities for country success and COVID-19 cumulative cases of (a) over 500 and (b) under 500 per 100,000 of the population. Examining 169 world countries and developing CSC Map, we used correlation and multiple criteria analysis methods. The priorities of the Country Success and COVID-19 Cumulative Cases World Map shown in Figure 3.5a are outlined next. The data found on the X-axis of the CSC Map displays the priorities of the country's success and, on the Y-axis, the cumulative cases of COVID-19 per 100,000 population. The results from the dimensions of the priorities of a country's success on the CSC Map come from (a) 8 and (b) 15 variables. Eight country clusters comprise the dimensions of this map; these relate to the classifications from the 2020 World Cultural Map and the 2021 World Values Survey. Two closely related country clusters, the English-speaking group and Protestant Europe, are combined into one, due to their common histories, cultural interactions, comparable developmental levels, and similar religious orientations. Results indicating improvement in the priorities of a country's success appear as movements to the left of the CSC Map. Meanwhile, cases of COVID-19 illness appear as an upward movement. How residents respond to the dynamic situation of COVID-19 illnesses can be forecast by where a country is located on the CSC Map. Evidentially, residents of successful

countries indicate a greater chance of sickness due to COVID-19. The CSC Map systematically displays concentrated clusters of countries that are polarized and interconnected. These clusters are independent of the countries under investigation. They are also independent of the quantity of their descriptive variables.

a)




b)

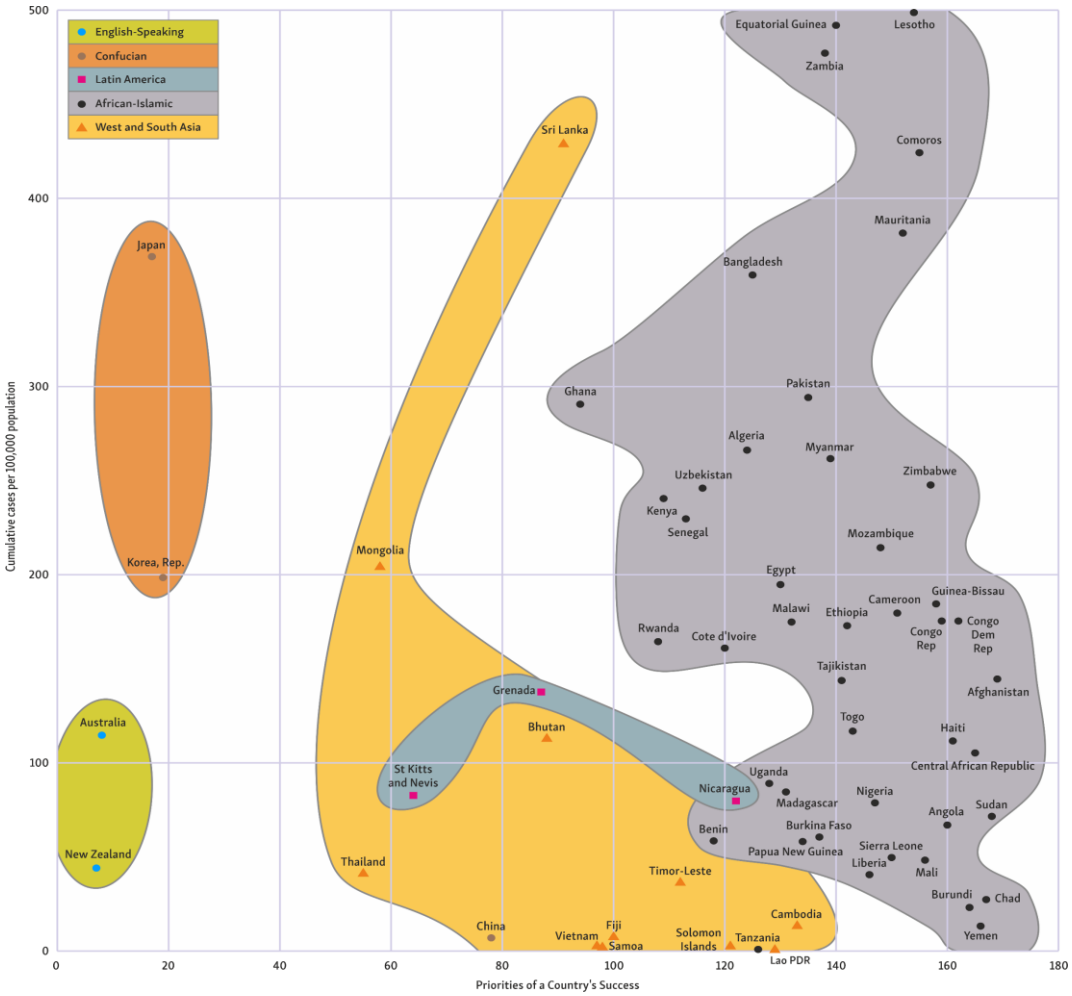



**Figure 3.5.** Country Success and COVID-19 Cumulative Cases World Map

The CSC Map displaying priorities for country success and COVID-19 cumulative cases of (a) over 500 and (b) under 500 per 100,000 of the population. The priorities pertinent to the success of countries appear on the X-axis, and cumulative cases per 100,000 of the population appear on the Y-axis of this CSC Map. The priorities pertinent to a country achieving success were established based on the INVAR method for a multiple criteria analysis,[15] as well as on a comprehensive consideration of a system consisting of (a) eight and (b) fifteen variables (Table 3.4) that describe the priorities leading to a country's success. The CSC Map consists of countries grouped into seven clusters taken from the 2020 World Cultural Map. This CSC Map contains an array of countries that were not analyzed by the 2020 Inglehart–Welzel Cultural Map of the World. The priority group that shows an improvement of a country's success level appears as a movement to the left on the CSC Map. COVID-19 cumulative cases are indicated by an upward movement on this map. Responses to the dynamic changes prompted by the COVID-19 pandemic can be predicted by the location of a country on the CSC Map. The people residing in the more successful countries face an increased chance of becoming sick with COVID-19. Country clusters systematically concentrate in a polarized and interconnected way on the culture map. These clusters are independent of the countries under investigation, as well as of the number of variables descriptive of a country.

The 12 countries included in Protestant Europe and the English-speaking cluster on the CSC Map match those on the 2020 World Cultural Map (Inglehart, 2021). According to the World Factbook (2021), Canada (offical English-speaking population: 58.7%, official French-speaking population: 22%) and Ireland (English is the official language, and it is generally used) are countries where English is a de jure and de facto official language. Therefore, Ireland was also added to the cluster (Figure 3.5a). Not all countries, such as Israel, are within their own clusters. However, this can be explained, as follows: The populations of countries

also matter. For example, the membership of the top 200 most influential intellectuals in the United States include half who are 100% Jewish by descent (Dershowiz, 1997; Chua and Rubenfeld, 2014). Americans who have won the Nobel Prize include 37% who are ethnically Jewish (Jinfo). Thus, it might be considered by some to be understandable as to why Israel appears alongside the United States on the CSC Map (Figure 3.5a).

Both on the CSC Map and the 2020 World Cultural Map (Inglehart, 2021), the Orthodox European cluster includes the same 13 countries. This European cluster also includes Cyprus because Eastern Orthodox Christians constitute 89% of its population, according to the World Factbook (2021).

On the CSC Map, 15 countries included in the Latin America cluster match those on the 2020 World Cultural Map (Chile is located in the West and South Asia cluster). The two Caribbean countries under analysis from the 2020 Inglehart–Welzel Cultural Map of the World (Inglehart, 2021) are Haiti and Trinidad and Tobago. The 2020 World Cultural Map (Inglehart, 2021) unnecessarily includes the Philippines, an Asian country which belongs to the West and South Asia cluster on the CSC Map. With an additional 15 Latin American and Caribbean countries, the Latin America cluster on the CSC Map includes 30 countries.

The West and South Asia cluster on the 2020 Inglehart–Welzel Cultural Map of the World (Inglehart, 2021) includes seven countries (India and Indonesia are located in the African-Islamic cluster). All of these countries are shown in Figure 3.5. In addition, Figure 5 shows all the countries from the West and South Asia cluster under analysis.

On the Inglehart–Welzel World Cultural Map (Inglehart, 2021), the African-Islamic cluster includes 34 countries. At the time of the creation of the CSC Map, some of Palestine's data for the 15 indicators was not available. All these countries are shown in Figure 3.5.

On the CSC Map shown in Figures 3.5 and 3.6, 13 countries in the Catholic European cluster (Andorra has been excluded, because some of its data for the 15 criteria were not available) match those on the Inglehart–Welzel World Cultural Map (Inglehart, 2021). In addition, this cluster includes Malta, where 83% of the population is Roman Catholic, according to the 2019 Eurobarometer. Estonia and Latvia are countries in the Baltic region of northern Europe. In the World Values Survey wave 6 map (2010–2014), Lithuania, Estonia, and Latvia had their own Baltic cluster, which has recently developed very close ties to Scandinavian countries. The latest Inglehart–Welzel World Cultural Map (Inglehart, 2021) no longer includes this Baltic cluster. Most post-Soviet countries belong either to the Catholic or Orthodox European cluster. Among the three clusters, Estonia and Latvia are closer to the Catholic Europe cluster and, therefore, have been included there.

The Confucian cluster on the Inglehart–Welzel World Cultural Map (Inglehart, 2021) includes six countries. At the time of the creation of the CSC Map, some data was not available for Taiwan (China), Hong Kong SAR (China), and Macao SAR (China). The remaining countries are shown in Figures 3.5 and 3.6.

Indications of priorities for countries appearing on the X-axis, and up to 500 cumulative cases per 100,000 of the population due to COVID-19 appearing on the Y-axis, constitute the CSC Map. Fifteen variables determine the priority of a country, which comprises one of the dimensions on the CSC Map. The development of the CSC Map involved adapting clusters from the 2020 Inglehart–Welzel Cultural Map of the World (Inglehart, 2021). The countries that do not belong to these clusters are not shown on the CSC Map. These countries include East Asian Mongolia, the Republic of Mauritius (an island in the Indian Ocean) and Oceanian Fiji, Samoa, the Solomon Islands, Mauritius, and Papua New Guinea. The CSC Map indicates the improvement of a country's priority results by moving in parallel to the left and rising cumulative cases due to COVID-19 by moving upward. Here, Australia, China, and New Zealand are exceptions to the rule (Figure 3.5b).

The Map of Country Success and COVID-19 Excess Deaths was created with the goal of performing a thorough examination of the interconnections between country success and COVID-19. The successes of countries, along with their excess deaths per 100,000 of the population due to COVID-19, are mapped out to indicate any relationship between them. A system of eight variables comprises the dimensions on the

CSC Map indicating the success of countries. A growth in a country's success results in a fall of the number of excess deaths due to COVID-19, which the Map clearly illustrates. The excess deaths per 100,000 of the population of the country represented decreases in parallel with its success. The 2020 Inglehart–Welzel Cultural Map of the World provided the eight country clusters for this study. Two culturally related country clusters, which were English-speaking and Protestant European, have been integrated into one cluster in this map. The compilation of this map only used data on 84 countries pertinent to excess deaths per 100,000 of the population due to COVID-19, which was sourced from *The Economist*. The 15 necessary indicators under consideration were not all available for six of the 84 countries that were submitted. Thus, only 78 countries were analyzed for this study. Countries that did not belong to the seven clusters under consideration, for instance, Mongolia in East Asia and Mauritius in Oceania, are not represented on the CSC Map. The two predominant dimensions—country success on the horizontal X-axis and excess deaths on the vertical Y-axis—show the differences between different societies and clusters. The site of the country on the CSC Map is established by these two dimensions. Indicators of country success and sustainability express the common values inherent to a country cluster (Figure 3.6).

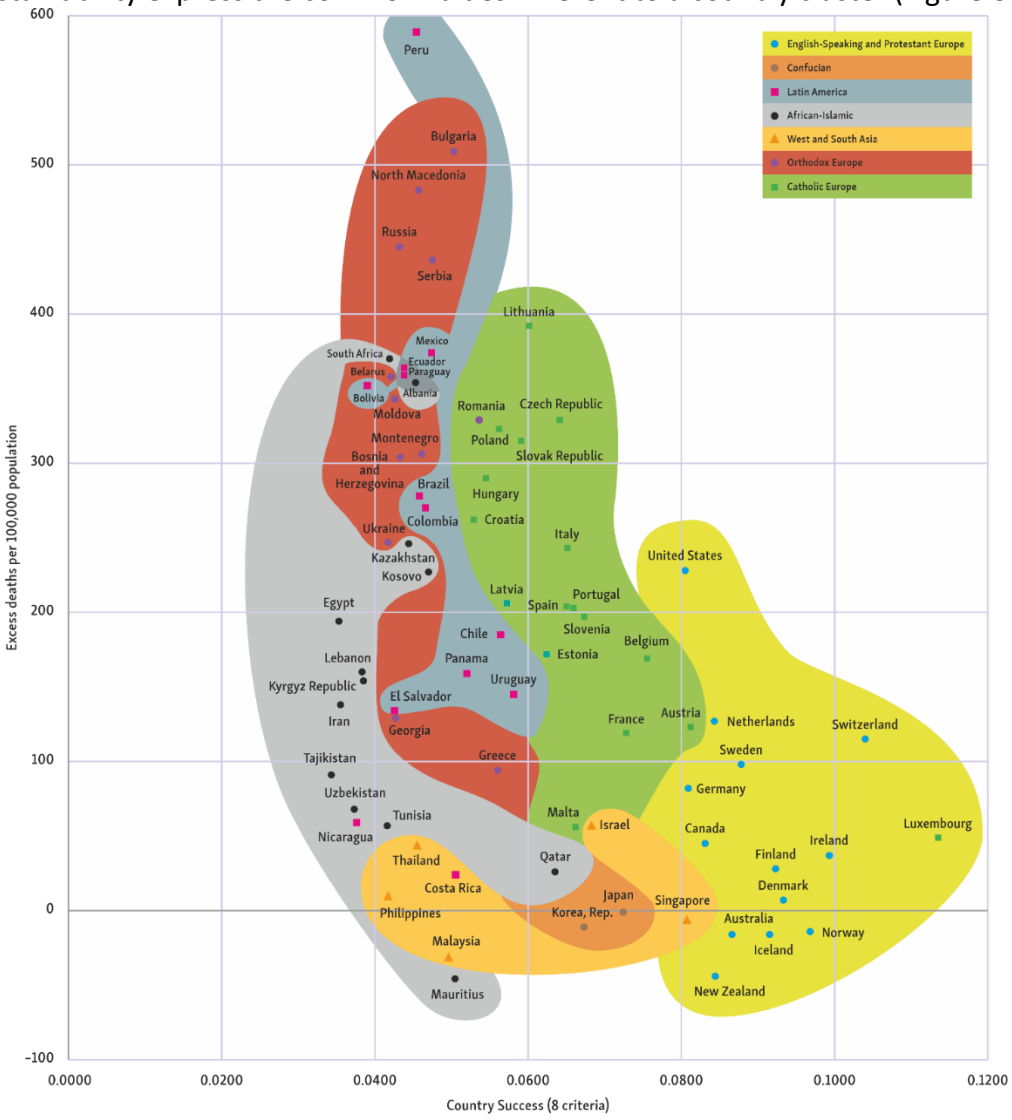



**Figure 3.6.** Country Success and COVID-19 Excess Deaths World Map

A thorough investigation of the link between a country's success and COVID-19 excess deaths is represented. The Country Success and COVID-19 Excess Deaths Map was employed to serve this stated objective. It visually displays the link between the successes of countries and their respective COVID-19 excess deaths per 100,000 of the population. A system of criteria consists of eight variables (Table 3.4).

This composite of variables comprises the country success dimensions on the CSC Map. This map shows a decline in COVID-19 excess deaths whenever country success is on an upswing. Heightened success appears in parallel with fewer excess deaths per 100,000 of the population for countries. Two dimensions highlight the predominant differences among countries. The horizontal X-axis on the CSC Map displays the country success dimension. Meanwhile the other vertical Y-axis displays the excess deaths dimension. The location of a country on the CSC Map relates to these two dimensions. Indicators of country success and sustainability reflect the values that country clusters share in common.

Figure 3.6, which shows the Country Success and COVID-19 Excess Deaths World Map, is explained next.

On the CSC Map, 11 countries included in the Protestant European and the English-speaking cluster match those on the Inglehart–Welzel World Cultural Map (Inglehart, 2021). The UK has been excluded, because *The Economist* (2021a) does not provide its data on excess deaths per 100,000 of the population. Many indicators analyzed in this research and characterized as a group by a country's success indicators suggest that Luxembourg is much closer to the countries in Protestant Europe and the English-speaking group than to those in the Catholic Europe cluster. For a while, Luxembourg was in a political union with the Netherlands as a result of the Treaty of London. The administrative languages spoken in the country are Luxembourgish, French, and German; the country has borders with Germany, France, and Belgium. Only three countries in Europe allow euthanasia: Belgium (since 2002), Luxembourg (since 2009), and the Netherlands (since 2002) (Coutinho, 2016). No wonder, then, that Luxembourg falls into the Protestant European and English-speaking cluster (Figure 3.6).

Both on the CSC Map and the Inglehart–Welzel World Cultural Map (Inglehart, 2021), the Orthodox Europe cluster includes the same 12 countries, but *The Economist* (2021a) provides no data on excess deaths for Armenia.

The Latin America cluster on the Inglehart–Welzel World Cultural Map (Inglehart, 2021) includes 16 countries. *The Economist* (2021a) provides no data on excess deaths for six countries: Argentina, Guatemala, Venezuela, Haiti, Puerto Rico, and Trinidad. With the addition of El Salvador, Panama, and Paraguay, the Latin America cluster on the CSC Map includes a total of 13 countries.

The West and South Asia cluster on the Inglehart–Welzel World Cultural Map (Inglehart, 2021) includes seven countries (India and Indonesia are located in the African-Islamic cluster). *The Economist* (2021a) provides the data on excess deaths for only five countries in the West and South Asia cluster; they are all shown in Figure 3.6.

The African-Islamic cluster on the Inglehart–Welzel World Cultural Map (Inglehart, 2021) includes 34 countries. At the time of the creation of the CSC Map, some of Palestine's data for the 15 indicators was not available. *The Economist* (2021a) provides the data on excess deaths for only 13 countries in the African-Islamic cluster, and they are all shown in Figure 3.6.

Therefore, Figure 3.6 visually supports the second point of Hypothesis 3 that as the success of a country grows, excess deaths from COVID-19 per 100,000 population decrease in parallel. This figure clearly shows that the increasing priority of country success, from left to right, corresponds to decreasing excess deaths from COVID-19 per 100,000 population

Not all countries, such as China, Israel, Estonia, Latvia, and Tanzania are within their own CSC Map clusters. For example, an oddity on the CSC Map is Tanzania, which is not in its African-Islamic cluster. Nonetheless, it is near the African-Islamic cluster. Another is China, which is near to Vietnam on the CSC Map, as these countries share a border (Figure 3.5). An analogous situation exists in other similar studies, which we briefly describe below.

Some boundaries of the cultural zones overlap: The ex-communist zone, for instance, overlaps with the Catholic, Protestant, Orthodox, Confucian, and African-Islamic cultural zones. The situation is similar in Britain, which is both an English-speaking country and historically a Protestant European country. Britain is close to all six of the other English-speaking countries, which puts it in that zone on our map. With a minor adjustment, though, Britain—due to its cultural closeness to Protestant societies—could

have ended up in Protestant Europe on the map. Reality is complex. Thus, the empirical position of Britain, a country at the intersection of Protestant Europe and the English-speaking zone, reflects both aspects of reality. Another boundary, even broader, could put Catholic Europe, Ireland, Latin America, and the Philippines in a broad cultural zone of Roman Catholicism. All of these zones can be justified both empirically and conceptually. The two-dimensional cultural maps take into account the similarity of basic values. At the same time, they reflect how these societies are different and distant from each other in many other dimensions, such as their colonial influences, the impact of communist rule, the level of economic development, religion, and the structure of the workforce (Inglehart and Welzel, 2005).

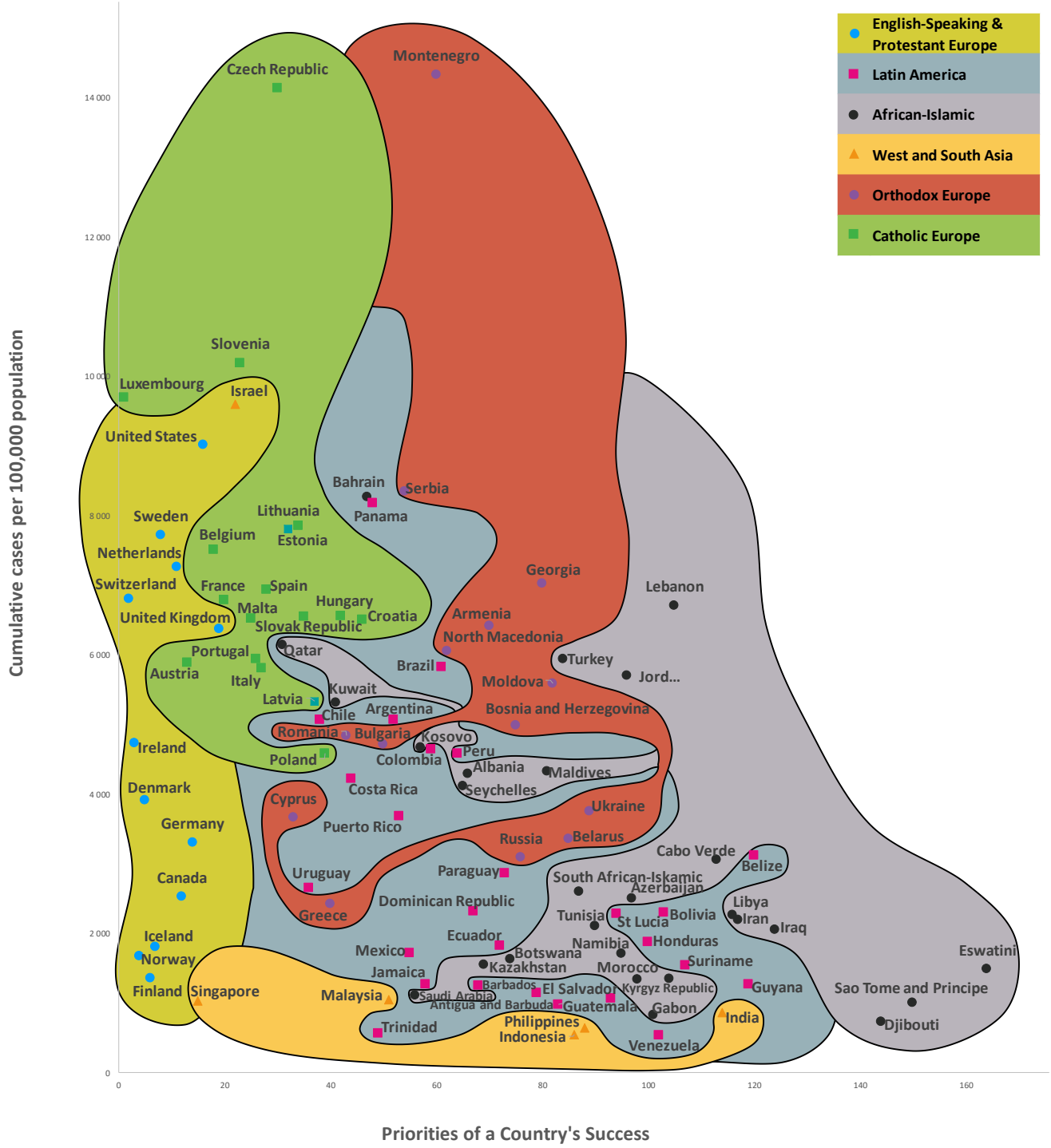
*The former and the current world powers form the pool of English-speaking* countries; there are more features shared by West Germany with Sweden than with the other countries. New Zealand and Australia share more features with the former and the current world powers than with each other. The social set-up of Canada is close to that of Great Britain, Norway, Sweden, and the USA, and Finland is somewhat different from the other northern countries. These are all instances of various similarities and differences (Haller, 2003). The following dimensions mapping these distances *of* class profiles are possible (Haller, 2003): common culture, historical connections, the welfare state, and industrial development. In the context of the discussion proposed by Haller (2003), this typology also serves as a warning against thinking that the label "Europe" means the European countries share more similarities with each other than with other countries.

The CSC Map of the world presented here visually validate the hypotheses raised, along with the statistical studies that have been performed using the data.

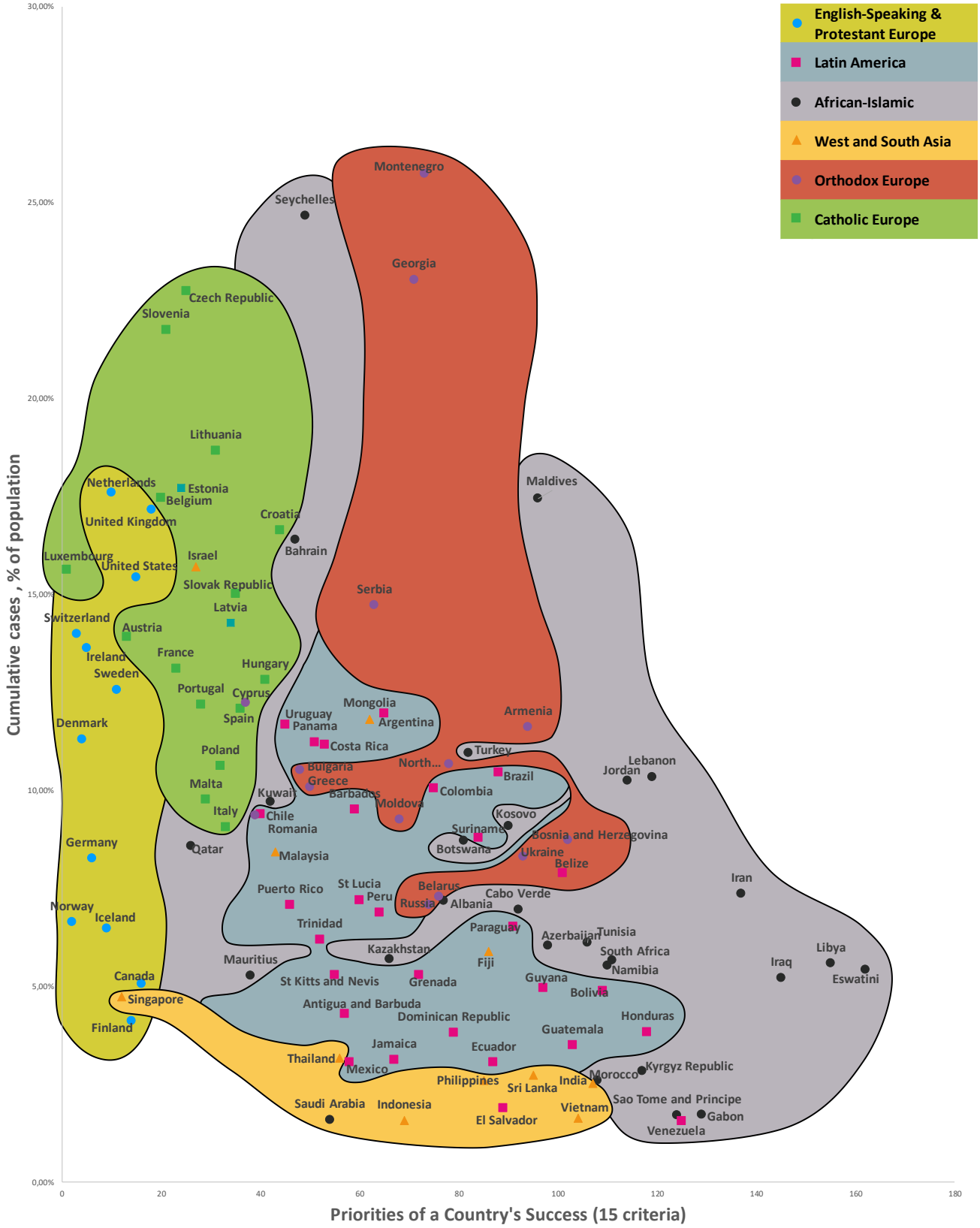
Figure 3.7 compares the Country Success and COVID-19 Cumulative Cases World Maps from (a) March 28, 2021 and (b) December 23, 2021. CSC Map displaying priorities for country success and COVID-19 cumulative cases of (a1) over 500 and (a2) under 500 per 100,000 of the population (Figure 3.7a). Also, Figure 3.7b shows priorities for country success and COVID-19 cumulative cases of (b1) over 1.5% and (b2) under 1.5% of the population. The priority of a country's success is based on 2020 data, and has been calculated using (a) an eight-citeria system and (b) a 15-criteria system. The y-axis is identical on both maps. The data on cumulative cases per 100,000 population (Figure 3.7a) have been transformed and expressed as a percentage (Figure 3.7b). One thousand infections per 100,000 population on the CSC Map in 7a1, for instance, correspond to 1% of a country's population infected on the CSC Map in 7b1, and 3,000 infections per 100,000 population in 7a1 correspond to 3% infected in 7b1 (Figure 3.7).

The position of country clusters on the CSC Map changes little over time. For instance, the bases for analyzing cumulative cases per 100,000 population were the March 28, 2021 data (Figure 3.7a, WHO, 2021a) and the December 23, 2021 data (Figure 3.7b, WHO, 2021b). These data show strong, positive and statistically significant dependency ($r=0.939$, $p<0.01$). The bases for analyzing excess deaths per 100,000 population were the August 31, 2021 data (Figure 3.6, *The Economist* 2021a) and the December 22, 2021 data (Figure 3.7, *The Economist* 2021b). These data show strong, positive and statistically significant dependency ($r=0.942$, $p<0.01$). The layout of the clusters over time on the CSC Map is very similar, and their correlations are, as well (Figures 3.7a and 3.7b). The percentage of people ill with COVID-19 in 169 countries, as per the December 22, 2021 data, indicates a strong, negative and statistically significant relationship on the priority ranking of a respective country's success, based on 2021 data. These numbers were established according to a 15-criteria system ($r=-0.646$, $p<0.01$) and according to an 8-criteria system ($r=-0.678$, $p<0.01$). Almost nine months later, the overall country clusters show little change in their position on the CSC Map. Only two clusters in the middle of the CSC Map (African-Islamic and Latin America) show a noticeable change in their boundaries.

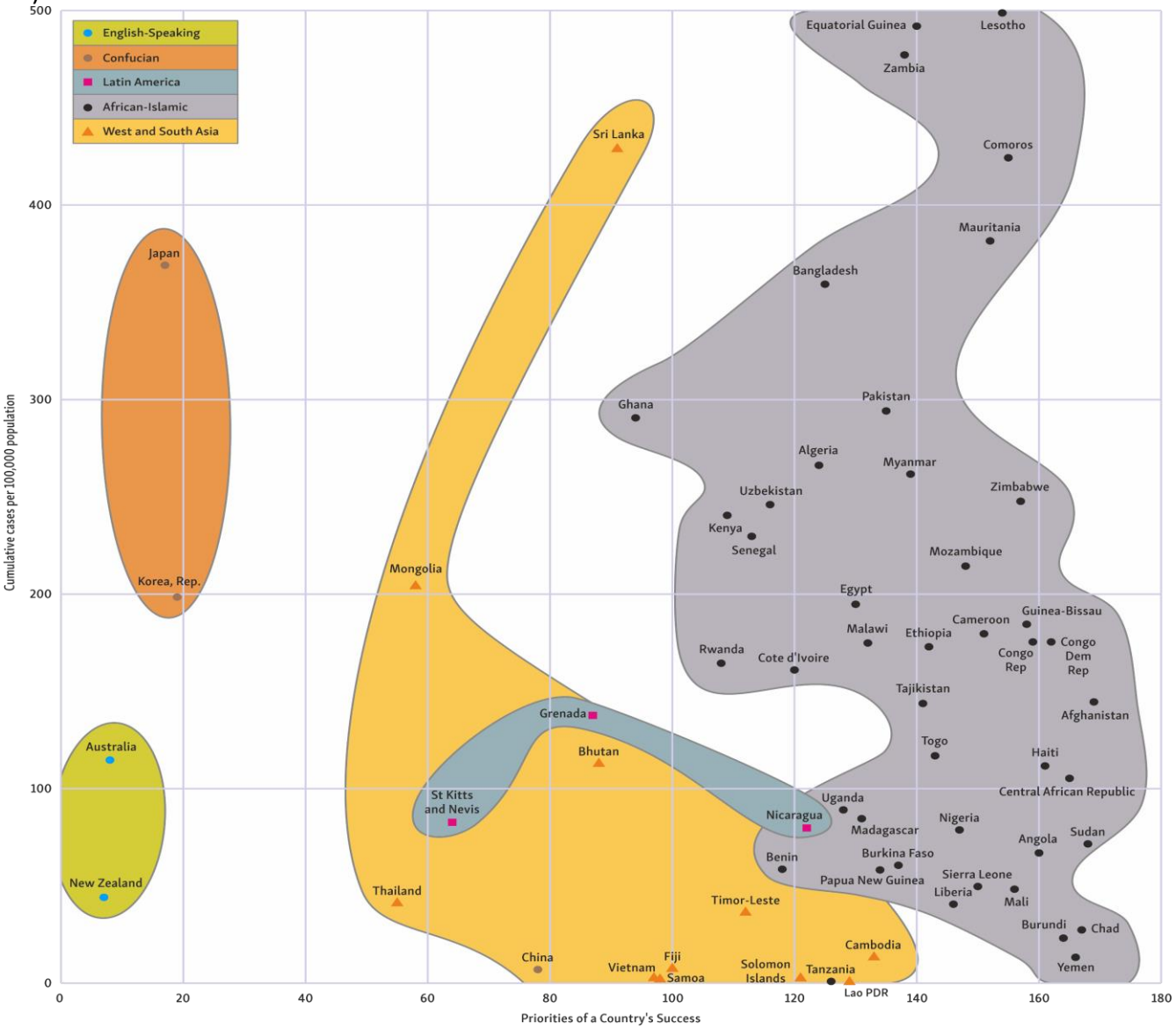
a1) COVID-19 cumulative cases, March 28, 2021



b1) COVID-19 cumulative cases, December 23, 2021



a2)


English-Speaking
Confucian
Latin America
African-Islamic
West and South Asia
Cumulative cases per 100,000 population
Priorities of a Country's Success
0
100
200
300
400
500
0
20
40
60
80
100
120
140
160
180
Equatorial Guinea
Lesotho
Zambia
Comoros
Mauritania
Bangladesh
Sri Lanka
Japan
Ghana
Pakistan
Algeria
Myanmar
Zimbabwe
Uzbekistan
Kenya
Senegal
Mozambique
Mongolia
Korea, Rep.
Egypt
Guinea-Bissau
Cameroon
Malawi
Ethiopia
Congo Rep
Congo Dem Rep
Rwanda
Cote d'Ivoire
Tajikistan
Afghanistan
Grenada
Togo
Bhutan
Haiti
Central African Republic
Australia
St Kitts and Nevis
Uganda
Nicaragua
Nigeria
Madagascar
Angola
Sudan
Benin
Burkina Faso
Papua New Guinea
Sierra Leone
Liberia
Mali
New Zealand
Thailand
Timor-Leste
Burundi
Chad
Cambodia
China
Fiji
Vietnam
Samoa
Solomon Islands
Tanzania
Lao PDR
Yemen

b2)

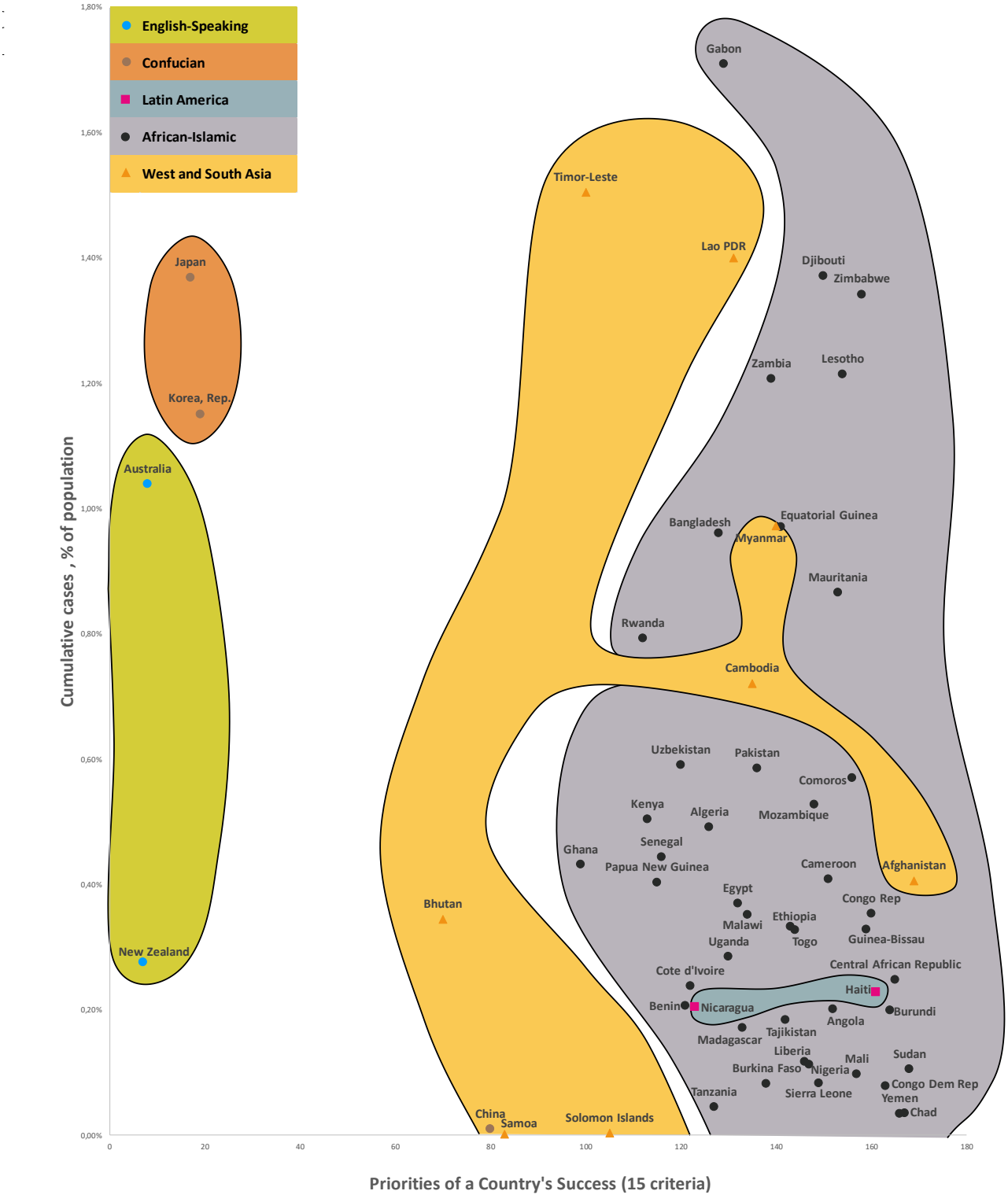



**Figure 3.7.** CSC cumulative cases per 100,000 population, a visual comparison of Country Success and COVID-19 Cumulative Cases World Maps, (a) March 28, 2021 and (b) December 23, 2021

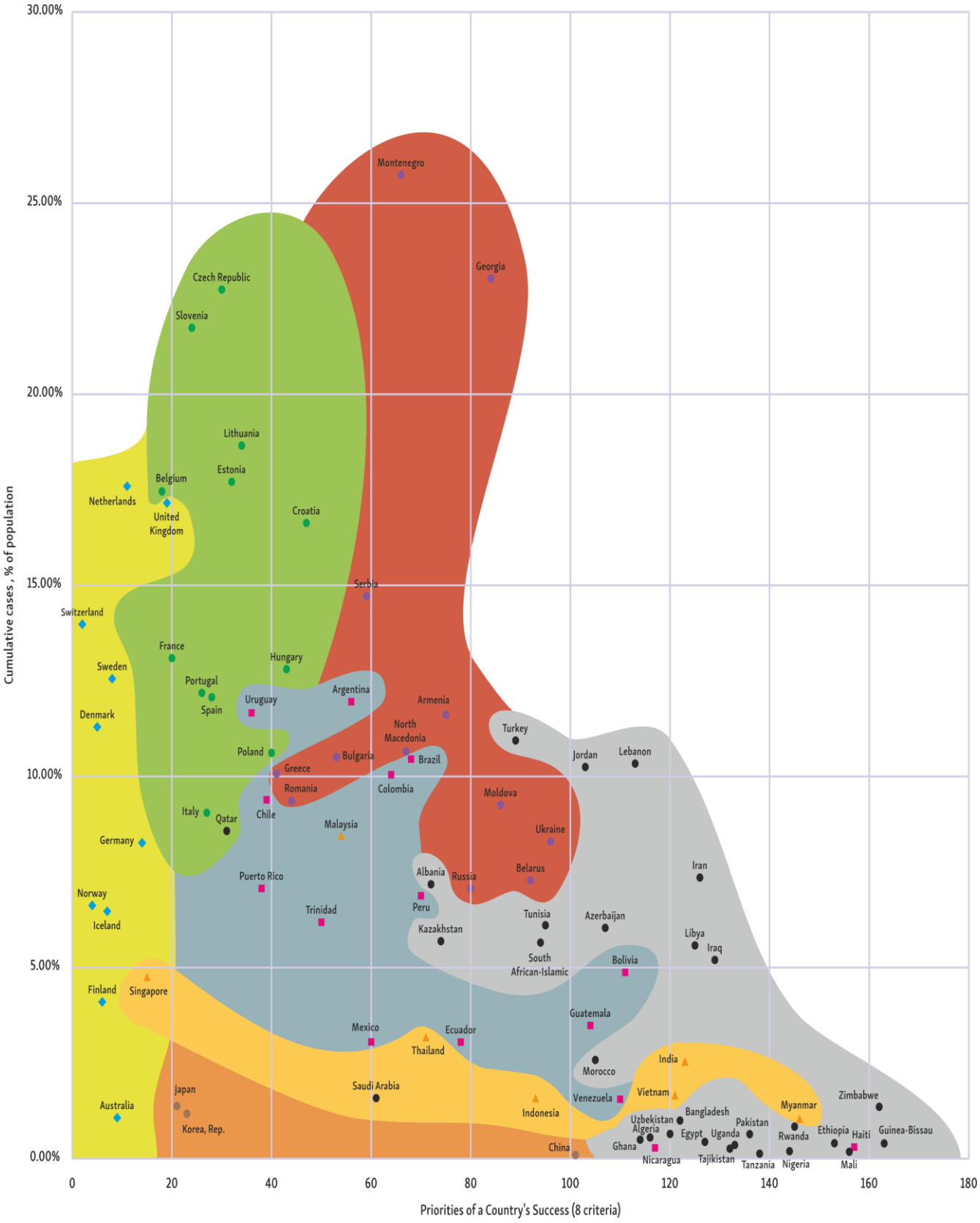



**Figure 3.8.** The Country Success (2020) and COVID-19 Cumulative Cases (December 23, 2021) World Map with the 2020 World Cultural Map countries

Figure 3.8 shows the Country Success and COVID-19 Cumulative Cases World Map with the 2020 World Cultural Map countries. This map is a visual confirmation of the claim stated in the first point of Hypothesis 3 that as the success of a country grows, cumulative cases increase in parallel. This figure makes it evident

that an increase in country success priority (from right to left) corresponds to an increase in COVID-19 cumulative cases.

People's values and behaviors are determined by culture (Hofstede, 2001). Therefore, specific manifestations of culture in human behavior can influence the spread of pathogens (Fincher et al., 2008). The CSC Map and models, as well as the statistical analysis, confirm the idea of statistically significant relationships between cultural factors and COVID-19. The CSC Map and models are important tools in attempts to determine reasons behind the spread of pandemics and to find rational ways for successful fight against a pandemic.

The review of world literature in the field, found in Subsection 1, as well as the CSC Map and models showed that both the more and the less successful countries have their strengths and weaknesses, when it comes to battling COVID-19. Furthermore these countries have differing traditions as well as unlike situations in culture, politics and their economy. None of these are exceptionally better at dealing with the threat raised by COVID-19. The Results and Discussion sections, found further in the research, also discuss the Country Success and COVID-19 Map of the World.

### 3.2.5. Validation of the fourth hypothesis: Changes to the 2019 and 2020 country results

The fourth hypothesis has been verified by means of the method of qualitative comparison. This method compares the values of the variables included in our research set with the values of the variables used in studies by other authors and their changes before and during the pandemic.

The data used for the validation of the fourth hypothesis referencing that micro-, meso- and macro-environments limit people's pursuit of freedom under pandemic conditions, were taken from different databases and websites, including the World Health Organization, Transparency International, World Bank, Eurostat-OECD, Knoema, Global Data, statistics from global and country economies, Freedom House, Global Finance, Heritage as well as from various other publications.

Sustainability relevant to the coronavirus pandemic has again sparked a public debate. Global restrictions on the public regarding their movements and contact with other people, diminished business activities, slumping air travel, and other means of transport have had positive results. Consequently, harmful emissions have declined, and water quality has improved. Unfortunately, greater sustainability may be impeded due to the social and economic disasters which are occurring, and which threaten progress worldwide (Deutsche Bank, 1997).

Many success and sustainability indicators have steadily improved throughout the twentieth century (excluding periods of crisis) for the 169 countries under analysis. From the perspective proposed by Inglehart and Welzel (2005), existential conditions have been improving more and more, as a result of socioeconomic developments. Furthermore, at the same time, the public have made more autonomous choices because there are fewer external constraints in place. The contributing factor to such increasing existential security prompts the emergence of values of self-expression. This, in turn, prioritizes individuality and liberty over discipline and collectivism, as well as over conformity. As human diversity is viewed as necessary, group mindsets are discounted, resulting in civic autonomy over state authority. The inherent value of self-expression is emancipation, which is also people-centered. Therefore, a different sort of humanistic society unfolds, which encourages people's freedoms and autonomous actions in many ways (Inglehart and Welzel, 2005).

The Freedom in the World survey, which reviews the civil liberties and political rights with respect to each country in the world, is administered every year. The data from this survey indicate that the number of free countries in the world dropped from 86 to 82 between 2019 and 2021. *The Economist* Intelligence Unit, publisher of *The Economist*, a weekly journal, compiles the democracy index. The objective of this index, as it self-describes, is to measure countries to assess their respective states of democracy. Between 2019 and 2020, the index experienced a reduction from 5.44 to 5.37 on the global scale. According to

Economist Intelligence Unit (2021), democracy was dealt a severe blow in 2020, and nearly 70% of nations documented a deterioration in their total score, as state after state locked down to protect lives from a new coronavirus (*The Economist*, 2021a). Today's conditions are characterized by a sharp and unmatched drop in the human development index, as suggested by the UN Human Development Report (Conceição et al., 2020). This report adjusted the education dimension in the study to account for impacts caused by school closures, improvement measures, and other means.

The survival of humanity is clearly facing a threat from the COVID-19 pandemic. People feel let down by society, are consumed by a growing sense that they have no prospects, and have become more upset, afraid, and hostile. Reported hedonism and positive emotions have plunged, and people see their lives as worse than before in many areas, including finances, the joy of living, their mental and physical health, personal, work, social life, and their trust in humanity (Lampert et al., 2021). Although the coronavirus pandemic has grievously affected the world this year, certain countries, such as Canada, have experienced more sadness than others, as the United Nations confirmed in its 2021 World Happiness Report.

Particularly vulnerable people are facing financial insecurity or are living in poverty, often in unaffordable or overcrowded housing; in addition, they are socially isolated, or experiencing poor psychological well-being. Also among the groups at higher risk are people in precarious jobs, low-income earners, people in need of support for disabilities or mental health care, and people living in households with the threat of violence or domestic abuse. Governments need broad and coordinated policies to support the most vulnerable people with swift and decisive action (Fu et al., 2020).

The 2021 Economic Freedom Index graded 89 of 178 countries in relation to their registrations of economic freedom improvements. The results showed that scores had dropped in 80 countries, with nine remaining stable.

The measures countries introduced in response to the COVID-19 pandemic—including the shut-down of economic activities—resulted in an economic recession and growing unemployment, which will decrease the quality of life and increase all-cause mortality (Harris et al., 2020). Nordt et al. (2015) looked at global public data from 63 countries to model the effect of unemployment on suicide, and noticed a 20–30% higher suicide risk associated with the 2000–2011 unemployment levels (including the 2008–2009 financial crisis). Rosén and Stenbeck's (2020) calculations showed that with an increase of 100,000 people unemployed in Sweden, about 1,800 more premature deaths could be expected during the next nine years. The unemployed are likely to lose, on average, two years of their remaining life expectancy. With unemployment rates that are already (or expected to be) higher (in some cases two or three times) than those in Sweden, many other countries are likely to have hundreds of thousands of unemployment-related excess deaths (Rosén and Stenbeck, 2020).

Governments and investors are struggling to handle the social impacts on health and economies during the COVID-19 crisis. Unfortunately, in 2021 the OECD has issued troubling reports. Apparently there will be a deficit of USD 1.7 trillion in financing for developing countries. Yet, such investments are sorely needed for these countries to achieve the named objectives pertinent to the 2030 Sustainable Development Goals (SDGs). Sustainable development trends have become negative due to the COVID-19 pandemic. Many wasteful practices designed to avoid physical contact have been on the upswing since 2020, such as the vastly increased use of single-use products, and travel in private vehicles (Ellwanger et al., 2020).

A computational methodology with an enlarged Maslow's hierarchy of needs has been recommended by Suh et al. (2021) This involves a difference-in-differences approach, which corrects variations in seasonality and volume, and provides for a holistic view of society after the pandemic, as its needs will have changed, comparatively. These authors applied this approach in a study involving over 35 billion search interactions across 36,000 ZIP codes over a 14-month period. This provided the basis for the characterization of changes in the physiological, socioeconomic, and psychological needs of people across the USA. They discovered that a focus on basic human needs has been expressed at exponentially greater rates, whereas higher-level ambitions have dropped in comparison to the pre-pandemic period.

The studies presented above show that numerous success and sustainability indicators for many of the 169 countries under analysis constantly improved during the calm periods of the twenty-first century. Therefore, in 2020, it is possible to assert that numerous indicators of economies, societies, and political actions worldwide worsened over the COVID-19 period, in comparison with 2019. This study also demonstrates that the micro-, meso-, and macro-environments limit people's pursuit of freedom under pandemic conditions. These freedom needs become markedly more important as the threat of the pandemic recedes. Meanwhile they worsened during times of crisis, such as, e.g., during COVID-19. The fourth hypothesis was this way confirmed.

Additionally the later sections on Results and Discussion analyse changes to the 2019 and 2020 country results.

### 3.3. RESULTS

**Country Success and the COVID-19 Map of the World**

A practical comparison was made to establish correlations between the dimensions (axes) of the CSC Map and the Inglehart–Welzel 2020 Cultural Map of the World. Table 3.1 displays the calculated correlations between all dimensions when analyzing 169 or fewer countries. Upon performance of the correlation analysis, it was established that strong, positive, and statistically significant relationships exist between $CS_{15}$ and $CS_8$ ($r=.985$, $p<0.01$), $CS_{15}$ and traditional versus secular-rational values ($r=.846$, $p<0.01$), $CS_8$ and traditional versus secular-rational values ($r=.849$, $p<0.01$), as well as between $CS_{15}$ and traditional versus secular-rational values ($r=.706$, $p<0.01$). The dimensions of the 2020 Inglehart–Welzel Cultural Map of the World correlate with one another (.570**), similarly as its dimensions correlate with the dimensions of the CSC Map. The average correlation with dimensions of the CSC Map and the traditional versus secular-rational values is 0.637**, whereas with the traditional versus secular-rational values – 0.561** (Table 3.1).

The parallel analysis of 169 and 77 countries yielded comparable results. Once the number of criteria pertinent to country success (CS) was reduced from 15 ($CS_{15}$) to 7 ($CS_7$) and 8 ($CS_8$), the results of the correlations did not change by much. *The analysis results pertinent to the correlations between the CSC Map and the 2020 Inglehart–Welzel Cultural Map of the World dimensions substantiated t*he first *hypothesis. Additionally a clear, visual validation of this first hypothesis appears in Figures 3.5 and 3.6, where the seven clusters of countries under deliberation concentrate in groups.*

Put simply, the distribution of countries and their movements running diagonally on the X-axis (Country success) and on the Y-axis (cumulative cases per 100,000 population) on the CSC Map reflects the values of clusters and achieved results of success. Put another way, cumulative cases usually increase naturally, whenever the success rate of that respective country is on an upswing (Figure 3.5). Meanwhile excess deaths from COVID-19 per 100,000 population decrease in parallel (Figure 3.6).

Thus, Figures 3.5a and 3.5b again graphically confirm the second hypothesis that when the numbers of countries indicators change, the conditional successes of countries remain fairly similar.

The CSC Map contains seven zones of country success and COVID-19 clusters, which were obtained by analyzing smaller or larger numbers of countries and the various numbers of variables describing them. Once the locale of a country on the CSC Map is known, a forecast is possible regarding the actions of its residents in response to dynamic changes in the COVID-19 situation. The research results from this study correspond with the research results of several global studies under analysis, listed below. Generally, the countries with the most advanced economies tend to be freedom-oriented, and these tend to suffer more COVID-19 cases. Meanwhile countries that tend to be more control-oriented experience fewer COVID-19 cases (Lampert et al., 2021). Thus, the outcomes of this study coincided with the results obtained by Maaravi et al. (2021), which found that populations that tend to uphold concepts of freedom, self-expression, autonomy and individualism (i.e., those that reflect relatively open societies) suffered the most during the initial nine months of the coronavirus pandemic.

As the success of a country grows, cumulative cases increase, while excess deaths from COVID-19 per 100,000 population decrease in parallel. *The visual validation of* the third *hypothesis also appears in Figures 3.5 and 3.6 of the presented CSC Map of the World, in which the seven clusters of countries under deliberation are concentrated in groups. The statistical studies that have been performed substantiate* the third *hypothesis, as well as the submitted CSC Map.*

Development of the CSC Map involved an analysis of 169 countries. Meanwhile the 2020 Inglehart–Welzel Cultural Map of the World only submits 103 countries.

Moreover, CSC Map Models, which are formal representations of the CSC Map, were developed to confirm hypothesis 3. According to these models, whenever there is a 1% increase in GDP per capita, human development index, global gender gap, environmental performance index and democracy index values, then the cumulative cases will also increase, correspondingly, by 0.38, 3.45, 3.57, 2.15, and 1.25 percent. Meanwhile, excess deaths will also decrease, correspondingly, by 0.52, 3.79, 1.76, 1.32, and 1.03 percent.

**Changes to the 2019 and 2020 country results**

The fourth hypothesis concerns meeting basic needs. Accordingly, efforts to avoid severe illness and death during the pandemic are essential to survival, and, for the time being, these constitute fundamental priorities. Thus, people tend to temporarily push the need for freedom into the background. Now, state authority, group conformity, and collective discipline acquire greater meaningfulness in society. Once the threat from the pandemic lessens, the need for freedom becomes markedly more important. Our analysis and existing global statistical data have substantiated the fourth hypothesis. This hypothesis represents the main difference between material needs for safety and non-material human needs for freedom. Society usually ranks safety higher than human freedom, and the COVID-19 threat directly affects safety. On the other hand, once the COVID-19 threat has passed, major concerns will again relate freedom. For the 169 countries under consideration, the average values of the 15 success and sustainability indicators improved consistently during the twentieth century (except in times of crisis). The success and sustainability indicators under analysis decreased during 2020 compared to 2019 (i.e. the pandemic period), as expected.

Therefore, the conclusions of this research concurred with the following outcomes of Lampert et al. (2021): The COVID-19 pandemic is a clear threat to survival. The coronavirus pandemic has led to an increased focus on health and vitality, and many people are keener on taking precautions (Lampert et al., 2021).

This is a proposal to form a database on best practices in managing the COVID-19 pandemic. It can then serve as a basis for numerous metrics and existing contextual conditions to analyze the most rational application on an ongoing basis.

**Effect of air pollution on country lockdowns**

The analysis conducted here was on the success and sustainability of 169 countries as well as on the interdependencies of their environmental performance index (EPI) and current air quality score. Such an interdependency demonstrates that environmental indicators are better as a country's success and sustainability improves. Furthermore, this analysis included an examination of COVID-19 excess deaths in 78 countries and the interdependencies of their EPI score and current air quality score. These independencies demonstrate that, as these environmental indicators deteriorate, the numbers of COVID-19 excess deaths increase. Upon performance of the correlation analysis, it was established that strong and statistically significant relationships exist between 169 countries' success and sustainability linked with their current air quality ($r=.602$, $p<0.01$) and EPI scores ($r=.931$, $p<0.01$). Additionally, it was determined that statistically significant relationships exist between COVID-19 excess deaths per 100,000 population in 78 countries and deaths per 100,000 population attributable to ambient air pollution ($r=.5$, $p<0.01$), current air quality index score ($r=-0.413$, $p<0.01$), and EPI score ($r= -0.627$, $p<0.01$). The various

restrictions and preventative means, such as lockdowns at home and social distancing policies, which were applied to fight the pandemic, did improve a country's EPI score and current air quality score indicators. The obtained results show that, as a country's EPI score and current air quality improved by 1%, excess deaths decreased, by 2.33 and 1.55 percent, respectively.

Knowledge on the science of integrated analyses pertinent to country successes and COVID-19 (CSC) globally has been augmented by the studies outlined next:

- The very first integrated analysis pertinent to country successes and COVID-19 cumulative cases and excess deaths globally is the study presented here. New Country Success and COVID-19 Map of the World have been compiled for this research on a worldwide scope.
- The four hypotheses raised and confirmed over the course of this research established that, around the world, a many country's success continues to increase over time, while the numerous indicators so describing it continue improving. Consequently the inhabitants of a country pay increased attention to their needs for freedom, liberty and autonomy.
- The 2020 Inglehart–Welzel Cultural Map of the World, which is grounded on surveys, and the CSC Map, which is grounded on statistical indicators, have axes that correlate with one another significantly.
- The indicators in the criteria system regarding country success and sustainability are interrelated. Thus, when the numbers of countries and their indicators change, the conditional successes of countries remain quite similar. Likewise seven clusters of countries under deliberation group together independently of the system of applied indicators for their analysis.
- As the success of a country grows, cumulative COVID-19 cases increase, although excess deaths due to such cases, per 100,000 population, decrease in parallel.
- Micro-, meso- and macro-environments limit certain people's pursuit of freedom under pandemic conditions.
- Possibilities generated for interested groups with the assistance of the INVAR method and the CSC Map and models are the following:
  - to compile development perspectives based on a more thorough and deeper picture of COVID-19 control and prevention alternatives
  - to develop and analyse COVID-19-related restrictions and preventative measure alternatives more effectively by rationally reducing the negative effects of the COVID-19 pandemic
  - to analyse and interpret the existing data quantitatively and qualitatively for deriving the kinds of results prompting automatically submitted recommendations aimed at different stakeholders pertinent to reducing the impact of COVID-19

### 3.4. DISCUSSION

These research outcomes provide a scorecard and practical guidelines for countries that desire means for effectively resisting this pandemic, and for transitioning to a sustainable future.

Most countries need to undertake swift actions in their efforts to control the lifecycle of the pandemic more effectively and to strengthen their responses with systemic policies, by applying the best worldwide practices. Moreover, various means must be taken to support developing countries, which face huge difficulties in controlling the pandemic.

This study is the first global and integrated analysis on country successes and COVID-19 cumulative cases and excess deaths. The system of 15 indicators comprehensively defining the success and sustainability of 169 countries served as the basis for the development of the Country Success and COVID-19 (CSC) Map of the World. This research demonstrates the interdependencies between the policy responses that countries aimed at the coronavirus pandemic and their respective success and sustainability indicators. Country success variables taken from those modelled for the CSC Map Model explained more than 63% of the dispersions pertinent to COVID-19 cumulative cases, more than 52% of

COVID-19 excess deaths, and over 95% of country success variables. Practical conclusions and recommendations were derived based on the map, the statistical calculations, and the CSC Map models. One such conclusion is that the growing success of a country means its cumulative cases of COVID-19 are also increasing. Concurrently, numbers of excess deaths are falling in parallel. Freedom was one of the main problems experienced globally during the pandemic. This study further shows that, during the pandemic, respective micro-, meso- and macro-environments temporarily limit personal desires for independence. As the pandemic diminishes, such desires for freedom become increasingly important. This research improves understanding of how country responses to the coronavirus pandemic depend on their existing situations (success and sustainability indicators), which should serve as the basis for establishing specific policies. However, certain countries do not do this systematically. Medicine and other traditional means, for instance, do not constitute the only way to curtail excess deaths. It is possible to emphasize areas that have not been explored as much to date. These areas can include a stronger assurance of gender equality, the endorsement of human development, the elimination or reduction of corruption, and the improvement of happiness, education, and social progress.

The entirety of the evidence obtained by this research once more substantiated the interconnection between the ever-changing pandemic situations, namely the micro-, meso- and macro-environments of countries, along with their tailored policy responses to the COVID-19. Research results show that democratic countries usually respond most effectively to the pandemic, as they have sufficient resources and effective health care systems. The available evidence and best world practices also indicate that the most effective policy in response to the pandemic must be implemented while considering the big picture of the existing situation involving preparedness, use of broad-based testing and health care measures, poverty and economic inequality, gender inequalities, remote work possibilities, environmental well-being, human creativity, violent riots, and civil wars.

Upon analyzing the CSC Map (Figures 3.5 and 3.6) along with its relevant statistical calculations, it becomes quite clear as to how well different countries succeed at combating COVID-19, based on the numbers of cumulative cases and excess deaths per 100,000 of the population.

Numerous studies have shown that an improving environmental performance index has a positive effect on GDP per capita (Cracolici et al., 2010; Kapitány-Fövény and Sulyok, 2020) quality of life (Gallego-Álvarez et al., 2014; García-Sánchez et al., 2015), labor productivity (Mazzanti and Zoboli, 2009; Bucher, 2017), health (Lannelongue et al., 2017), ease of doing business (Ansari et al., 2019), corruption reduction (Mavragani, 2016), human development (Gallego-Álvarez et al., 2014; Maccari, 2014), gender inequality (Abelinde, 2012), happiness (Kaklauskas et al., 2020), education (Agarwal, 2018), and social progress (Saisana and Philippas, 2012). The results derived by these studies emphasize the necessity of improving environmental indices, namely EPI, even after the the threat of the pandemic recedes. Low EPI scores usually characterize less sustainable and successful countries—the same countries that have been hardest hit by COVID-19 excess deaths per 100,000 population.

Annually the death toll attributable to air pollution worldwide is some seven million people. Unfortunately, nearly the entire population worldwide (99%), as per WHO data, is breathing air with pollutant levels that exceed the limits established by WHO guidelines. The highest exposures are suffered by low- and middle-income countries (World Health Organization, 2020). Air pollution dropped during the pandemic. The results obtained by this study show improvements in environmental indicators (EPI and AQI). These results also indicate that the more successful and sustainable countries tend to show better EPI and AQI indicators. In the meantime, the numbers of excess deaths per 100,000 population prove lower. Obviously, the improvement in environmental indicators during the time of the COVID-19 pandemic is a great benefit to health and to the economy. However, in 2020, many of the other indicators of importance of a country's success and sustainability decreased.

The results of this study indicate that strict policies are not superior to policies of informed choices by residents, in terms of controlling COVID-19 excess deaths per 100,000 population. Both of these policies have advantages and disadvantages. The specific conditions of a country during the pandemic determines

the effectiveness of such policies. Nov et al. (2021), who analyzed preferences and patterns of reaction to community health throughout COVID-19, have submitted similar conclusions. Analogically, Haug et al. (2020) made an assessment of how well non-pharmaceutical interventions worked, depending on the local context, by employing country-specific, "what-if" scenarios. By conducting an analysis of self-interest (personal freedom) and prosocial (social-level well-being) framed COVID-19 avoidance policies, it was also established that their effectiveness depends on a specific situation (Jordan et al., 2020). The most positive results were achieved during the pandemic under policies which mostly depended on public trust, hand-in-hand with democratic accountability (Grogan, 2020).

The research results indicate that all the alternatives available for managing the pandemic have an array of advantages and disadvantages. None are ideal; therefore compromises are usually necessary. As curtailments have shown to negatively affect the economy, personal earnings, education, and mental health, the government of the UK, for instance, has announced it will cease almost all restrictions meant to stop the spread of COVID–19. The damage to the country has apparently been too great, so the argument is that relaxation is justified. Currently, the rate of infections is nearly the same as it was in February, a year ago, and hospitalizations and deaths are much lower, up to ten times less (Ball, 2021). Nonetheless, if the current rate of infection in the UK was happening elsewhere, the consequences would likely prove to be much worse (Taylor, 2021). Personal autonomy, independence, socializing, and extensive networking are apparently strong needs in certain countries, including Australia, the USA, the UK, Germany, Sweden, Spain, Switzerland, France, and others. However, resisting governmental rules and restrictions seems to be essential to upholding these highly valued democracies (Kapitány-Fövény and Sulyok, 2020).

The recommendation extended here to governments and other interested country institutions is to compile all possible non-medicinal alternatives for intervention. These then require assessment by numerous criteria, as well as in relation to the local context. Upon establishing rational combinations, it will be possible to react appropriately to the ever-changing COVID-19 situation.

The scope of the pandemic changes constantly as does the surrounding micro-, meso-, and macro-environments. Furthermore it is necessary to consider climatic parameters (Javadinejad et al., 2021; Talebmorad et al., 2021). Therefore it is essential to retain joint sustained learning, competence improvement, and an efficient citizenry. Furthermore, research and policy interaction in decision making must be based on the regional situation. Analogical discussions on the influence of interest groups, namely society, businesses, and others on policymaking are becoming more and more active, and not merely in the area of COVID-19. Increasingly, such discussions are actively transferring into issues of environmental sustainability and softening climate change (Fischer et al., 2011).

**Practical applications and implications**

Tylor (1871) states that culture as a term encompasses the norms and social behaviour characteristic to human societies and also the laws, beliefs, capabilities, habits, knowledge, arts, and customs of their individual members. Jackson (2006) believes a cultural norm serves as a guideline, a template for expectations in a social group and determines what conduct is acceptable in society related to demeanour in a situation, behaviour, language, and dress.

A number of authors have focused on the way national cultures are linked to motivation for adaptation to climate change (Noll et al. 2020), corporate carbon performance (Luo and Tang, 2021), corporate green proactivity (Wang et al., 2021), corporate governance, environmental sustainability performance (Peng and Zhang, 2022), and attitude to ecology (Tetyana et al., 2018). They looked at the link between national cultures and stock market volatility levels (Liu, 2019), individual trading behaviour (Tan, Cheong and Zurbruegg, 2019), corporate financial decisions (Kutan et al., 2020), stock markets' reaction to COVID-19 (Ashraf, 2021; Fernandez-Perez et al., 2021), and financial sector development (Khan et al., 2021). Other researchers have highlighted the impact of national cultures on human development by gender (Falguera et al., 2021), corporate governance and corruption (Boateng et al., 2021), e-government development

(Kumar et al., 2021), proactive career behaviours and subjective career success (Smale et al., 2019), employee performance (Udin, 2019), employee engagement (Zheng and Tian, 2019), and social relations (Berrell, 2021). Among other topics of analysis are links between national cultures and construction industry (Teravainen et al., 2018), organic farming industry (Manta and Toma, 2020), infrastructure sustainability (Meng et al., 2018), manufacturing competitiveness (Deif and Van Beek, 2019), SME profitability (Gaganis et al., 2019), SME efficiency (Abbasi et al., 2021), SME participation in Industry 4.0 (Buchholz, 2020), R&D investments (Choi 2020), risk-taking (Gaganis et al. 2019), firm characteristics and dividend policy (Chang et al. 2020), international business (Moore, 2020), services (Valtakoski et al., 2019; Liyanaarachchi, 2021), and supply chain integration in multiple countries (Liu et al., 2021).

This research presents the implications related to the big picture of the research of CSC Map. To validate the results of this research, however, many more studies in different research fields are needed. This investigation, therefore, includes certain period-reliant factors and a set of specific criteria with specific weights. Future research to assess other periods and contexts will need descriptions comprising more variables with different weights. In addition to their inclusion in upcoming studies, these research findings would also contain additional research areas to prove the results of this multiple criteria analysis by means of the INVAR method (Kaklauskas, 2016) and CSC Map. In this additional analysis, national culture indicators (i.e. traditional values vs. secular-rational values, survival values vs. self-expression values) would be part of integrated multiple criteria analysis of various objects from different areas. The INVAR method (Kaklauskas, 2016) in this case could be used to perform multiple criteria analysis of various alternatives such as corporate carbon performance, corporate green proactivity and environmental sustainability performance, corporate financial decisions, financial sector development, human development by gender, corporate governance and corruption, e-government development, subjective career success, employee performance and engagement, social relations, industries, manufacturing competitiveness, SME profitability, efficiency and participation in Industry 4.0, R&D investments, international business, and services. Our research findings could thus be compared with similar research findings of the authors mentioned above. Like the CSC Map, it would also be possible to map aspects such as choosing foreign markets, global innovation index, carbon dioxide emissions, healthcare, pollution and others.

# 4. VILNIUS CITY CASE STUDIES

## 4.1. INTRODUCTION ON VILNIUS CASE STUDIES

The COVID-19 pandemic affected people's lives in a way as no one could have imagined and foreseen in urban development plans. Although we have been living in a pandemic regime for only a couple of years, the situation forces us to "overload" urban development plans and implementation strategies.

Research on the best practices in urban development shows that the humanization of the urban environment through the construction or renovation of green public spaces, pedestrians and cycle paths is of paramount importance for human health and mood. Prior to the pandemic, these urban measures were designed to meet the challenges of sustainable development and climate change. They become even more important during a Covid 19 pandemic.

Compared to other European capitals, Vilnius residents are satisfied with the quality of life in the city: air quality - 69% (10th place), noise - 76% (7th place), green areas - 78% (6th place). https://ec.europa.eu/regional_policy/en/information/maps/quality_of_life/).

Although Vilnius is a green city, but there is a lack of quality green spaces. Including the fact that the streets, although a large part of them are green, have a severe lack of green perimeter. Due to the sharp increase in the number of cars, people suffer from CO2 pollution and noise as the city has been developed at different stages and on different principles.

The case studies presents the efforts of Vilnius city municipality in humanizing Zirmunai and Naujamiestis residential areas. By applying complex and tactical urban measures in Zirmunai and Naujamiestis residentaial areas, Naugarduko street and sidewalks, its surroundings, building new pedestrian and bicycle paths, creating new, green public spaces, organizing community celebrations, street trade, etc., city encouraging people to like open spaces, streets and communicate safely. Green wave policy gives additional value to the humanization and aesthetic of the city.

City administration believe that positive emotions are an integrated assessment of the results that city leaders and urbanists seek when investing in and designing city public spaces. Gathering of the emotional data enables to reform/improve policy making and planning. The emotions result during COVID19 shows that Vilnius City management responded adequately to the situation and the decisions made resulted positive citizens emotions. Citizens' emotions to the environment improvements, cultural events enables businesses and institutions to understand better what impact it had and may have to the citizens' well-being.

Vilnius case studies are important for combating the consequences of Covid 19 as well as for sustainable development and climate change issues.

***Keywords:*** sustainable development, climate change, Covid 19 pandemic, humanization of urban environment, street and sidewalk, public space, human safety, green wave, health, emotions.

### 4.1.1. Overwiev on best practises

The Covid pandemic has drastically changed our relationship with public space. People still need to go outside, commute, work, study, play, socialize, and maintain a healthy mental state. In this situation, the streets and sidewalks have a special role to play: „Streets and their sidewalks, the main public places of a city, are its most vital organs. Think of the city what comes in mind? Its streets. If a city's streets look interesting, the city looks interesting; if they look dull, the city looks dull. < > To keep the city safe is a fundamental task of a city's streets and its sidewalks" [263].

In examining good practice for an effective urban response to COVID-19, examples were selected from world-renowned expert organizations:

a) **12 Key Principles for an Effective Urban Response during COVID-19**

UN-Habitat's discovered key principles for an effective urban response for COVID-19 that local and national governments should focus on to prevent the spread of the virus and to develop resilience to and preparedness for events of a similar nature [264].
Sampler of key principles:

- Public Spaces Are an Important Asset in a Time of Crisis;
- Well-Connected and Integrated System of Public Spaces Including Streets;
- Expand the Amount of Land Allocated To Public Space Including Streets;
- Embrace Flexibility of Functions;
- Public Space Can Be a Platform for Sharing (Connecting Places and People);
- Plan for the Self-Sufficient Neighborhood or "15-Minute Compact City Neighborhood".
- Systemic Change Doesn't Happen Without Supportive Policy;
- Etc.

**b) 3 projects of Humanization by Jan Gehl**

„Jan Gehl and partners" is a world wide design company. Their works are dedicated for research and design of livible, human cities. Recent studies are linked to the Covid pandemic [265].

***Market street in San Francisko (Fig. 4.1)***

As part of the Better Market Street Vision Gehl conceived three detailed streetscape designs that would be iterated across three rounds of public consultation:

- Initial design concept: Qualify the Better Market Street Vision (from transit corridor to cultural and economic heart of SF);
- To discuss the initial design concept and trade-offs.
- To look at the detailed streetscape designs and their alternatives.

The consultation sessions were invaluable for the project team, tapping into local knowledge and opinion whilst garnering support for the overall vision and its guiding values; the street as a place not a 'corridor', transit experience over efficiency, and thinking beyond segregated mobility users – everyone is a pedestrian.

The consultation process also made clear that the vision should not be thought of as a finalized plan, but a flexible framework for improving mobility and streetscape infrastructure according to the local districts existing strengths and weaknesses and imagined future.

As of January 2020 the city are underway with a number of 'quick fixes' and have removed private vehicle access from 3,5 km of Market Street, setting the conditions to establish the street's new design and kick off a new era in this iconic streets story.

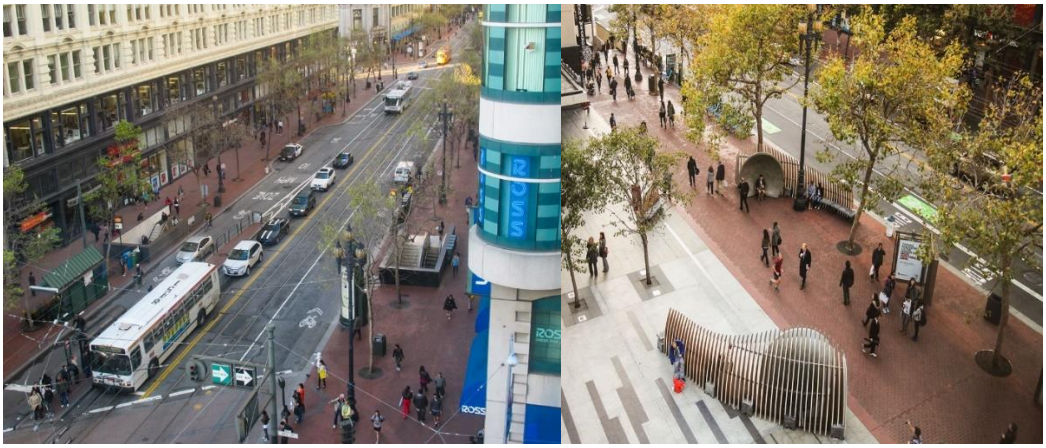


**Figure 4.1.** Left: Market street before. Right: Market street after

### c) “Adaptive Public Space: Places for People in the Pandemic and Beyond” [266]

In Knight Foundation funded projects in the US, Gehl analyzed and documented how the public spaces foster more equitable access and community resilience, along with recommendations for shaping more equitable public spaces based on the findings. Jan Gehl it stated: „The Covid-19 pandemic has shown how public spaces are more than just nice amenities; they are vital community hubs“.

In final Impact Assessment report, “Adaptive Public Space: Places for People in the Pandemic and Beyond,” holds insights for urbanists, foundations, community advocates, public officials and private-sector leaders interested in how responsive public spaces can thrive and be a vehicle for communities to address equitable development.

The findings from this impact assessment illustrate the power of public space as a platform for community development: whether by building resident trust, spurring social activity, supporting economic and workforce development, or catalyzing neighborhood change.

- After improvemnet populiarity of local meeting spaces in adjacent neighourhoods is 2 -2,5 times as much use (comparent to pre - lockdown data) inicates that school yards, pocket praks and small squares serve more of an outsize role in urban life than have previosly appriciated.
- Vilnius city municipality special attention paid to „ The Street design manual“.

Manual is New York City’s comprehensive resource for street design standards, guidelines, and policies. It draws from a wide range of resources and experience to present a coherent set of choices for street design. This Manual was created and published by the NYC Department of Transportation (NYC DOT) with contributions from a wide array of professionals from city government and the design field [267].

**Figure 4.1a**. The humanization of New Yourk streets [267]

### d) Humanization of streets in European cities

European Bank of Reconstruction support Barselona‘s urban planning activities after Covid [268]. Barselonas has a vision, that the new spaces will let residents get around quickly and safely while doing business more easily:

- Pedestrians will be given priority in many parts of the city.
- Low-speed zones will limit vehicles to 10 kilometres an hour.
- Nurseries, schools, sports centres, a library and a care home will be built or renovated.
- All new buildings will be designed to have nearly zero emissions.
- New bus lines and bicycle lanes will persuade people to keep their cars off city roads and reduce emissions.
- A tree-planting programme is being accelerated.

- The city will become more resilient to climate change, while helping people follow social-distancing guidelines.

Vilnius municipality adapt principles of humanization of streets used by other European cities [269]:

- In quiet traffic areas, which is one of the humanization solutions, cars usually move at 20-30 km/h. speed, traffic lanes are narrowed and visibility is determined by the appropriate parking arrangements. Cyclists or scooter enthusiasts usually move in a shared flow with cars, which ensures a wider network for sustainable mobility as no separate lanes are required.
- In the long run, such spaces create a calmer and more attractive environment, making them safer for independent children's travel. When the need to brake and accelerate decreases, drivers assess the obstacle on the road faster, can make eye contact, and line up more smoothly.
- Reducing speeds by about 10 percent reduces congestion and increases traffic throughput. In addition, people living near intense, polluted streets are less socially active - such streets are unattractive and their humanization encourages community building.

e) **How does the drive towards density play in the post - COVID age? [270]**

After years of migration from rural to urban centres, the idea of city living has had its shine taken off by several months of enforced isolation in high-cost, small-size apartments and an increased wariness of enclosed public spaces. As a Covid result, the number of London citizens wanting to work and live outside the city had jumped from 20 per cent to 51 per cent.

This period has highlighted some fundamental flaws in how many cities currently operate – chief amongst them being lack of access to outdoor amenities. The extension of indoor spaces in outdoors, embracing street life is central to the future of post pandemic city. Re-categorizing how we perceive and use outdoor urban spaces, as well as who these spaces prioritize, is now increasingly urgent.

### 4.1.2. Situation analysis of Naujamiesties residential area

Naugarduko Street pilot project was chosen by municipality as a catalyst for a humanization of Naujamiestis district, citizens mobility and the change of existing lifestyles. This issue is important for other soviet time residential areas.

Humanization/revitalization of soviet time residential areas is among priorities mention in the new City master plan 2030. Naujamiesties district/residential area is one of them [271].

Sustainable urban mobility plan (SUMP) has ambition from 2017 till 2030 to changes citizens' lifestyle in mobility. It is expected: on foot from 24.5 % to 29 %; by bicycle from 1,5 % to 7,5 %; by public transport from 24,1 % to 30,0 %; by cars from 49,9 % to 33,5 % [272].

Pilot project was launched by Vilnius city administration in collaboration with the architectural studio „Do architects". Architects prepared the feasibility study. Study notes that despite the obstacles and unattractive image of the district (lack of greenery, high car pollution and low pedestrian and bicycle access to the streets, law mobility, etc.), Naujamiestis residential area has untapped socio - economic potential, a fairly balanced service environment:

- **Population**. Naujamiestis has a population of 33,300 (Vilnius has a population of about 592,000). Compared to other parts of the city, the population density here is low, evenly distributed. The population structure is balanced, there is no single dominant age group. An analysis of children under 14 shows a general trend in the city: young families like to live on the outskirts of the city, in a more green environment.
- **Funcional connections**. Naujamiestis residential area is located near Vilnius Old Town, which in 1994 is included in the UNESCO World Heritage List. Street has very good functional coonections with the City Center and Old town (Fig 4.2).

**Figure 4.2.** Naugarduko Street – direct link with the City Center and Old town (photo S. Ziura).

- **Public service infrastructure** is characterized by a good supply of schools, kindergartens, health care institutions, commercial services (shops, beauty salons, etc.).
- **The engineering infrastructure** is not badly developed, but it is worn out in many places.
- **Buildings**. The district consists of buildings of various periods and styles: from historic buildings near the city's defensive wall and railway station to well-preserved modern / art deco examples from the early 20 th century, Soviet-era industrial and residential complexes. The territory is dominated by low-rise buildings, sessional (yard type) construction.
- **Real Estate**. The district has a large untapped development potential (about 1 million square meters of potential for residential, commercial and environmentally friendly production). There is a rapid conversion of production territories and buildings in it (the territories to be converted amount to about 400 thousand sq.m.). Compared to other prestigious districts of the city, real estate prices in Naujamiestis are lower, but have a tendency to grow due to location, convenient transportation and existing infrastructure. The fastest growing housing, offices, supermarkets.
- **Streets**. The existing network of streets with engineering infrastructure is able to supply the urban areas of Naujamiestis, although in some places it is worn out and requires investment. There is a lack of hiking and walking trails within the district and for communication with the Center and Vingis Park.
- **The main streets**. The main streets of the district are the historic St. Sepono, Naugarduko streets and Savanorių avenue (Fig. 4.3).

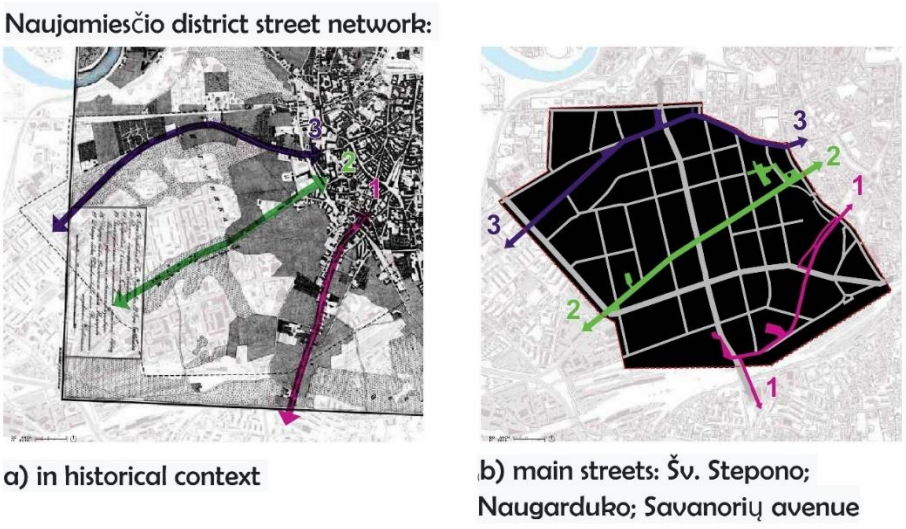



**Figure 4.3.** Main street network scheme for Naujamiestis district [273]

- **Public transport**. The district has a balanced communication system, a developed network of routes and stops.
- **Greenery**. The volume of greenery planting is growing in Vilnius (in 2017 - 1140 trees, and in 2020 - 2180 trees and 8417 shrubs). Assessed in the urban context and taking into account the valid norms (each inhabitant must have at least 10 sq. meters of greenery), there is a lack of greenery in Naujamiestis district, not all residents have the opportunity to reach greenery larger than 5 ha at a distance of 800 m (Fig. 4.4).

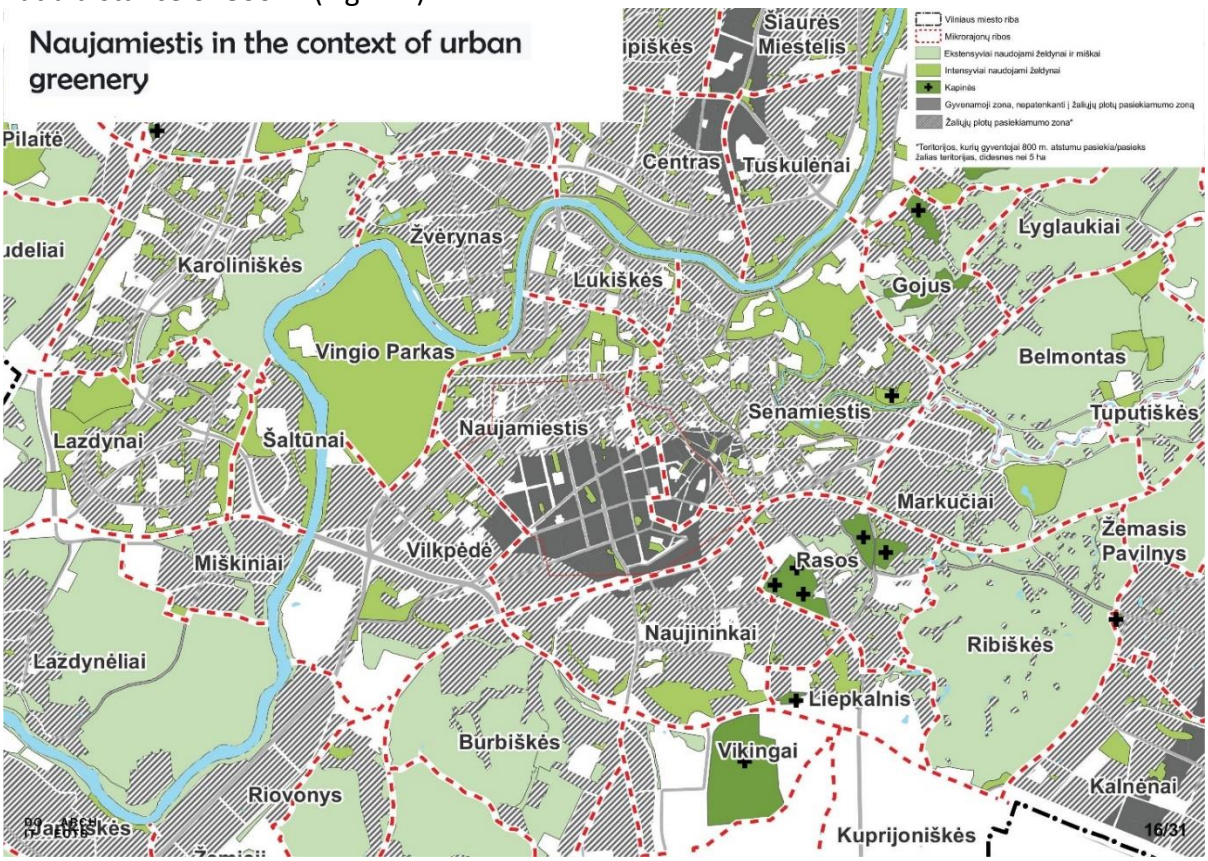



**Figure 4.4.** Naujamiestis in the context or urban greenery [274]

- **Active communities**. The district is characterized by a fairly active business and creative community. There are 12 active communities in the district with traditions and areas of activity (Fig. 4.5). The role of an active society in transforming the urban environment is of paramount importance, as it is their place of residence, work and rest.

The role of society involved in the early stages of creating a vision and turning it into a design task was particularly important. The initiatives of the students of the Faculty of Architecture should be mentioned - the future architects not only sketched, but also by playfully actions drew up the attention of the residents to the street and its potential to the public.

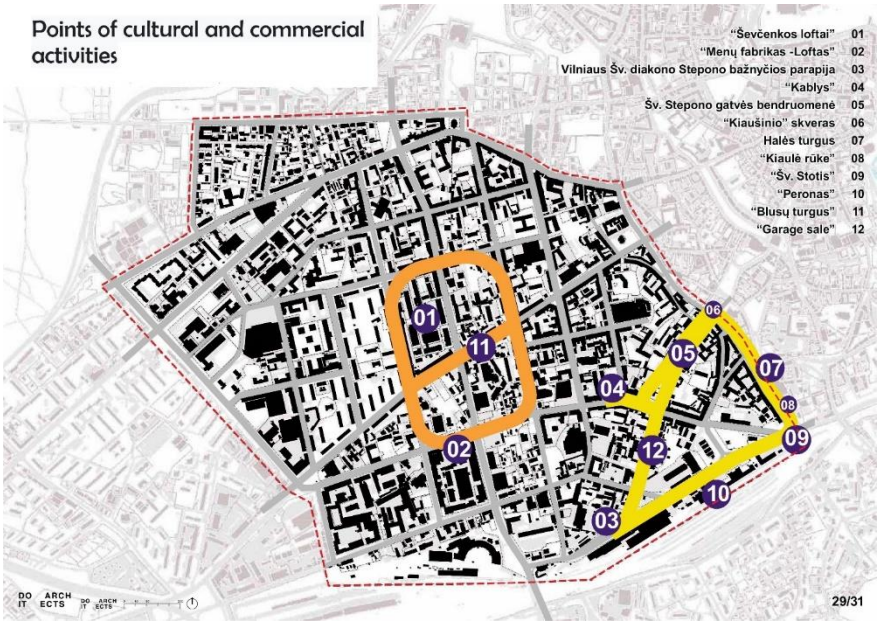



**Figure 4.5.** Community Rings [273]

### 4.1.3. Vision / concept of Naugarduko street as quit traffic street and new public space

The initiators of the project - Vilnius municipality together with the architects and active communities agreed on the Vision of Naugarduko Street (Fig. 4.6):

- Naugarduko Street - The central axis of Naujamiestis must become the main public space of this neighborhood – quit traffic zone, lively, cozy, green and safe.

The concept of quit-traffic streets allows to expect safer movement not only for cars, but also for pedestrians and cyclists, which creates a livelier and more attractive living environment. Solutions for quit-traffic movement and public spaces in the street has become the first example to attract a street market or "traveling courtyards".

For the Vision Vilnius City Municipality has set the following goals:

- The street must become a public space visited by people - it must be cozy, safe and green.
- The street should be lively in the evening, and there should be markets and events on weekends. There would be a place to sit to drink coffee in the sunshine.
- Bicycle and scooter trails must make Novgorod hill easy to cross.
- The reconstruction of Naugardukas Street must become an example for the humanization of other city streets. It needs to teach people to use the street as a public space.
- It is palnned to plant: 70 trees and 3144 shrubs will be planted on the Naugarduko street.

**Figure 4.6.** Visualization of Naugarduko street vision (source: possibility study. Do architect, 2019).

The analysis of the existing streets revealed a real possibility to give an aesthetic, greener image, to create small public spaces (Fig. 4.7).

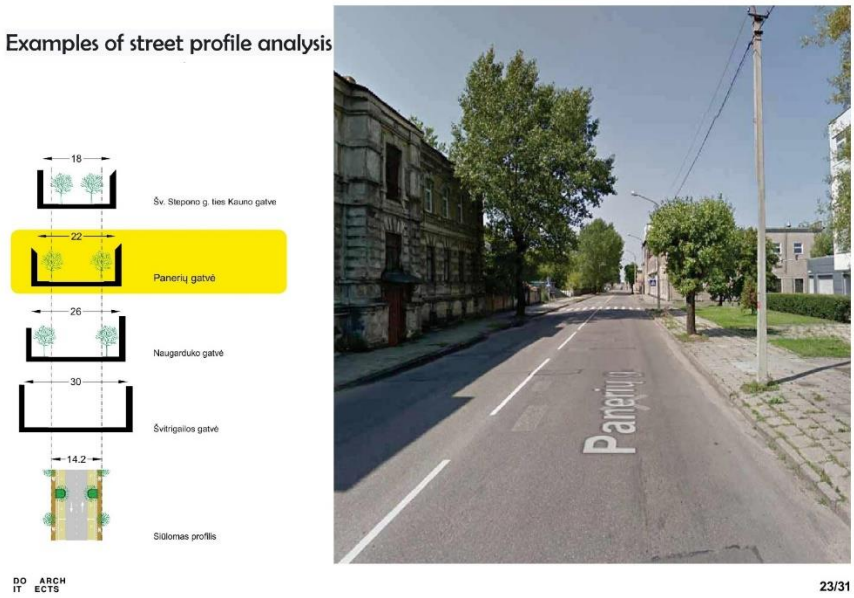



**Figure 4.7.** Street profile analysis [273]

We understood the need to manage other streets, and the need to have a more detailed plan. The urban planners of the consulting service agency MMAP has developed - the schemes by which we continue to manage the streets. Also, they performed an analysis of the adaptation of Naujamiestis streets to a quiet traffic zone, a survey of residents and prepared a concept for the redevelopment of these streets. Public presentation on findings has already taken place [275].

### 4.1.4. Implementation

The design work along with implementation was divided into steps.

**STEP 1. Design & Implementation 2020.** In the first step, new pedestrian crossings were installed in the sections of Naugarduko Street between the main intersections. Bicycle lanes were painted on both sides of the street, and many bicycle stands are installed.

Shrubs and trees planted, equipped with "islands" with integrated benches. Garlands and flags were hung to create coziness and a sense of celebration (Fig. 4.8).

Events organized for street revitalization: Flea market, Naujamiestis market, Open kitchen. Street terraces for leisure were built (traveling courtyards).

**Figure 4.8.** Celebrations in the Naugarduko street (photo S. Ziura 2020).

**STEP 2. Design & final implementation by 2022**. During implementation process, new pavements have been laid, new parking spaces have been installed (pavement - black pads 16x16).

Arranged sidewalk lighting. Street islands are being built in stages: pedestrian crossings, bus stops, intersections. Small squares, children's playgrounds and rest areas are being built at the newly installed intersections.

Major repairs of engineering networks in the main streets of a residential area are underway. These works hinder traffic, population mobility. However, these are necessary complex solutions that will improve the quality of life in the Naujamiestis residential area, give more attractiveness to investors, increase real estate prices.

2022-2023 Vilnius administration will observe the situation and complete the experiments. Whoever pays off, we leave, who doesn't - we don't.

### 4.1.5. Way to turn sustainable development challenges into reality

The Naugarduko Street humanization project is the city's effort and example in implementing the long-term sustainable development goals of the Vilnius City Master Plan (BP 2030) and the City Urban Mobility Strategic Plan (SUMP 2030). Both plans were prepared with the active participation of the city community, received comments, the proposal was approved by the City Council.

In the Vilnius BP 2030 and SUMP 2030, main goal is sustainable development implemented by developing polycentric city structure; supporting internal development of the city (increasing efficiency of the irrationally urbanized territories); promoting multifunctional land use; achieving social integration and reducing development disparities; giving priority to public transport and cycling; by reducing pollution. These ambitious goals are implemented differently in each urban area, depending on the different situation.

In the summer 2021 Vilnius Mayor updated currents tasks in document City +. It pointed out that Vilnius is learning to turn challenges into opportunities. This issue especially evident during the pandemic, when a new approach to humanization of the urban environment arrived. Adjacent courtyards, streets

are being better maintained, new bicycle lines are being built, new public spaces are being installed, new trees and shrubs are being planted.

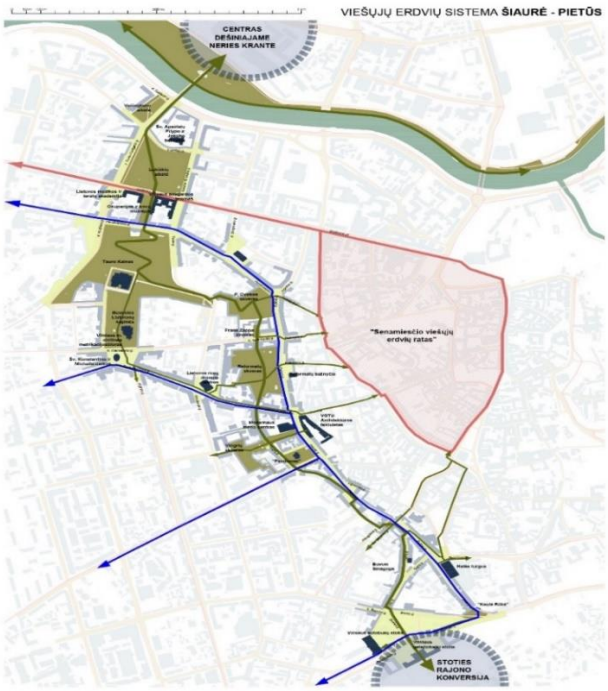



**Figure 4.9.** The system of Public spaces

Public spaces are being developed in Naujamiestis are so that people can reach not only the Old Town but also the New Center on the right bank of the Neris by foot or bicycle from the railway station (Fig. 4.9). So, Naugarduko street pilot project in the system of open spaces plays an important role for humanizing city, changing the way people live [276].

In long run - Vilnius aims to adapt the accessibility of the city's public infrastructure to the needs of the entire population by 2030: transport infrastructure - 60%, building infrastructure - 50%, public services - 70%, information technology and communications - 80%. These issues have been working on the accessibility of Vilnius railway station.

The shift towards Vilnius as a green and mobile city was already in progress before COVID-19, but the pandemic speeded up this trend. In the new Vilnius City Municipality policy „Green wave“during two year is scheduled:  to humanize all the main streets, to reduce the width of the streets to -3,00 m. Over the next two years, to plant: 10 million shrubs; 300 thousand creepers; 100 thousand trees.

**Fig. 4.10.** Implementation of Green wave, 2021 [277]

The current news is that the good experience of Naugarduko Street presupposed a new street standard, where the message is that the street is the main public space of the city is clearly established. 12 principles for how streets will continue to be humanized / reorganized were developed and present to the public [278]. It is believed that, the measures mentioned above will improve the quality of life in the city, serve for an effective urban response to COVID-19. In the future help to neutralize the CO2 footprint created in the city.

### 4.1.6. Conclusions

- Vilnius example of Naugarduko street humanization confirms the insights of world-renowned urban thinkers and designers about the importance of a safe, aesthetic urban street and its sidewalks, about very ecological and healthy very individual, with zero risk walking and cycling movement. It remains relevant in addressing the challenges of sustainabile development, climate change and overcoming the consequences of Covid 19.
- The public spaces are more than infrastructure, or anti - Covid measure, - they are vital community hubs, a step forward towards sustainable development in all over the city, as approved in the Vilnius Master Plan (BP2030) and Strategic urban mobility plan (SUMP 2030).
- After street and its surroundings humanization process, obvious changes have taken place: new cafes, shops, office buildings are being built, projects of nearby public spaces are currently being prepared and implemented, accelerated the development of real estate objects and the rise in real estate prices.
- Although the practise in adapting the streets and its sidewalks to public use is still relatively new and still continuing, as living in Covid 19 conditions. But it gives hope that having experienced the consequences of Covid 19, a long stay in isolation, people will support initiatives in the green, clean and safe street and sidewalk. They will move more on foot and by bicycle, will be more happy and healthy being more outdoors than indoors.
- In the ongoing COVID-19 crisis, many recommnedations are introduced at international or national level, but each city is a key to their implementation, to act as laboratory of innovative and bottom - up recovery strategies. Vilnius case is sampler how challenges can be changed to the opportunities.

## 4.2. GREEN ISLANDS

Vilnius is an unusually green city by most standards: more than 40 % of the territory is made up of forest, 4 % - agricultural land and other undeveloped land, 8 % - extensively and non-extensively used greeneries, 3% - water. The forest cover of Vilnius remains higher than the overall average of forest areas in Lithuania. Though, even being green, majority of living districts of Vilnius city still needs the complex rehabilitation having the in mind that they were developed in soviet times (starting from early 70'ties). The main task for the city urban policy is to satisfy citizens' needs for best quality of life and prevent negative consequences of climate change and pandemic situation with consequences on life habits - within 300 m. or 10 min walk distance to bring every citizen public or green space of sufficient quality and valuable biodiversity, to satisfy needs of different local stakeholders, to connect green city net by streets and transport corridors enriched with greeneries for better biodiversity and meeting pedestrian and cycling standards.

Coronavirus pandemic has brought Lithuania under quarantine since March 2020 and it made a fundamental shift to country's and City's live. Most of services have tried one way or another to adapt to the changed life conditions as well as people.

In the crisis period all possible ways of enjoying nature generate positive emotions that are very important in overcoming the depression that arises. In terms of sustainable development, the cities have become cleaner because there were less cars on the streets, people have learned to walk and ride bikes

more. Public green areas have become much more visited. Quarantine pause gave us time for better planning on urban infrastructure management and improvement, especially for maintenance roads and sidewalks, revised mowing frequency of meadows, planting trees, shrubs and perennial flower beds. City adminstration proclaimed recommendations for residents - not to cage themselves within four walls, but rather go on a walk, exercise outdoors or enjoy the nature. Special video for people who do not speak in Lithuanian languague was released https://vilnius.lt/en/2020/03/13/reccommendations-to-residents-how-to-protect-yourself-from-viruses/.

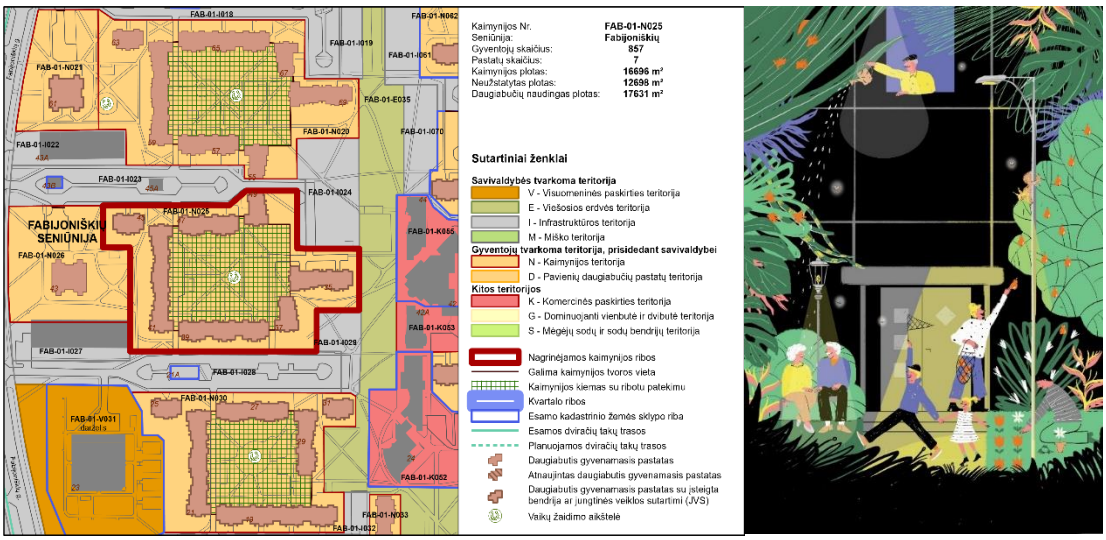
COVID 19 the negatively affected the emotions of the Vilnius citizens. Happiness Index in Vilnius was very low during quarantine, reaching only 15% (usually it was about 30%, and even 70% during holidays and fairs). At the same time the city administration continuously encouraged resident to stay active, not to lose the temper and try to enjoy the closest nature environment. Already few years in a row, initiatives, oriented to this main goal are constantly released. One of them - Walkable city. The city of Vilnius, trying to encourage Vilnius residents to walk or to travel by public transport as much as possible, created a joint network of walking trails. Twenty-four leisure trails, sixteen everyday walking trails and one hundred kilometers trail around Vilnius are planned. The trails have educational and recreational value; they connect natural sites. Walking is a good alternative to the usual journeys made by car and one of affordable tools even in quarantine circumstances. Today the city is friendlier for pedestrians and cyclists. More walkable streets in the central part of the city are planned. Recommendations of streets and public spaces suitability for universal use have been adopted. Design code for streets is under the development and will be prepared in the earliest future [279, 280].

On June 2, 2021 Vilnius City Council has approved the new **General Plan (GP)** of the Lithuanian capital, along the lines of which the city will live and develop for the next 10–15 years. What the strategic blueprint boils down to is that Vilnius will become more convenient for pedestrians and cyclists, there will be more green areas. GP also reflects the principles of the City + programme which include development of green spaces, modernization of residential areas, and development of social infrastructure. GP indicates that both green connections and green solutions are important for the living environment. In the densely built-up urban area, the GP intends to create a network of local green spaces, ensuring their availability within a distance of 200 to 300 m from housing and major urban parks so that they are no more than 2000 m away. The network of green spaces in the city will consist of urban parks, garden squares, connecting paths, and other green connections. Green spaces have been carefully inventoried in the GP, so their boundaries and areas are clear. It is planned to purchase popular green spaces, which today are located in private plots, on grounds of public interest or to ensure their public use in other ways. There are about 190 ha of such areas in the city. Small items of the natural framework are also listed.

### 4.2.1. Neighbourhood program as a tool for redesign of the living environment

There are different programmes and funds ran by the city in order to strengthen local communities for the re-development of the communal areas, public art and green functional spaces in different neighborhoods. In 2017 the Municipality has launched the Neighborhood Program that allows communities to fund some actions and redevelopments on their own. A few blocks of flats can join efforts and apply to the Program (see the picture below) for financial support (up to 10 Eur/sq.m of unbuilt area). Large housing estates (built before 1993) van be divided into small neighborhoods with common facilities, courtyards, entrances; Financial support is foreseen for renovation of outdoor space, infrastructure, greenery. It is to be assigned according determined criteria:

- Building/s owners should buy or rent land plot/s of neighborhood for not less than 10 years,
- All buildings' owners have to sign join venture agreement and appoint person/company responsible for implementation and take common decision on implementation.




Following goals set up in City Master Plan and regulation on protected natural landscapes, parks and reserves Vilnius municipality is gradually working on a very ambitious **Green Vilnius Policy.** It intended to characterize the main goals and actions to be taken in next 10 years for specific maintenance and use of different urban landscapes, to define different methods and pool of actions for preservation, maintenance and enhance of natural value of cityscape. Goal of city is to create green infrastructure as a tool for boosting ecological capacity of the city and struggle the consequences of climate change. The green area in Vilnius contains 49% of city area and requires high capacities of maintenance and monitoring, essential financial investments as well as openness for public involvement. Open data -Green Vilnius map- on green and public realm is complying with main targets for planning, maintaining, presenting, and monitoring of green city recourses such us trees, shrubs, flower beds, smaller or bigger green spaces. More and more architectural competitions are being announced looking for the best ideas on parks and public spaces design. In year 2020-2024 competitions were fulfilled and few more are underway.

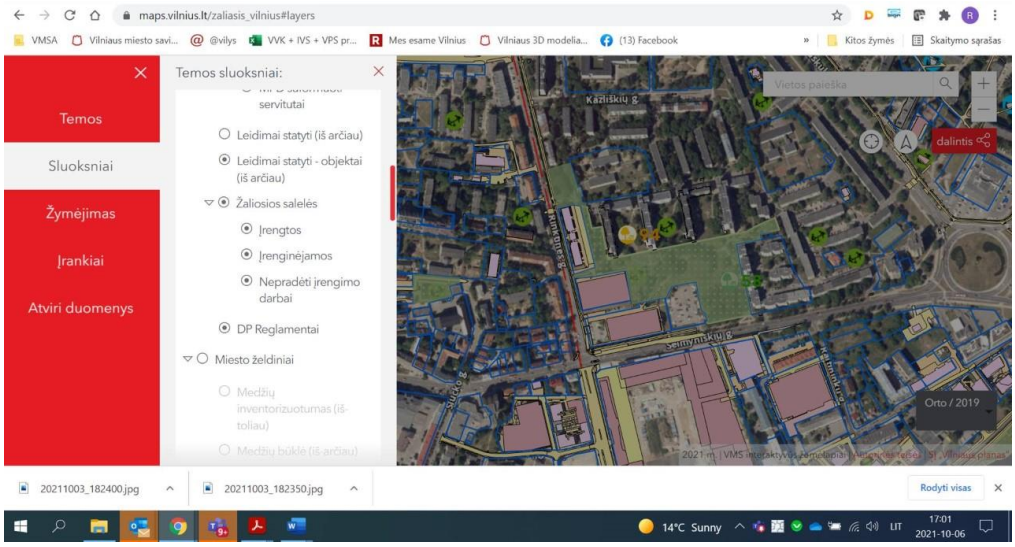
### 4.2.2. “Green projects” with accordance to the main Strategic documents of Vilnius Municipality

On June 2, 2021 Vilnius City Council has approved the new **General Plan (GP)** of the Lithuanian capital, along the lines of which the city will live and develop for the next 10–15 years. What the strategic blueprint boils down to is that Vilnius will become more convenient for pedestrians and cyclists, there will be more green areas. GP also reflects the principles of the City + programme which include development of green spaces, modernization of residential areas, and development of social infrastructure. GP indicates that both green connections and green solutions are important for the living environment. In the densely built-up urban area, the GP intends to create a network of local green spaces, ensuring their availability within a distance of 200 to 300 m from housing and major urban parks so that they are no more than 2000 m away. The network of green spaces in the city will consist of urban parks, garden squares, connecting paths, and other green connections. Green spaces have been carefully inventoried in the GP, so their boundaries and areas are clear. It is planned to purchase popular green spaces, which today are located in private plots, on grounds of public interest or to ensure their public use in other ways. There are about 190 ha of such areas in the city. Small items of the natural framework are also listed.

Green islands. During COVID19 lock down in 2020 Vilnius municipality has initiated plan – to construct 100 small squares of up to 100 sq. meters size in the densely populated living districts. The plan was born in 2019 under the Vilnius City Municipality project "Green Islands". When the quarantine bolts were finally loosened, residents of many Vilnius districts found 52 new places to revive neighbourhood relations. Program is continuing, new small squares (islands) are being developed, and local people are invited to adopt those mini squares continuing maintenance and use of it. City is planting more plants around installed islands. More active local involvement is planed – city is planning to invite residence to

compliment those islands with plants by themselves and to encourage locals to adopt this micro infrastructure [281].

Every user can find a layer with extended information about the Green islands at https://maps.vilnius.lt/zaliasis_vilnius. Here we have a possibility to find information where and in which stage every green island is.



Residents of Karoliniškės, Viršuliškės, Šeškinė and Justiniškės neighbourhoods already have a pleasant surprise – small green spaces next to their homes, where they can rest, read and rub shoulders once again after all the long months of COVID 19 lock down. Municipal company „Grinda“, the project contractor, started works in April 2020, with a slight delay due to the coronavirus pandemic.

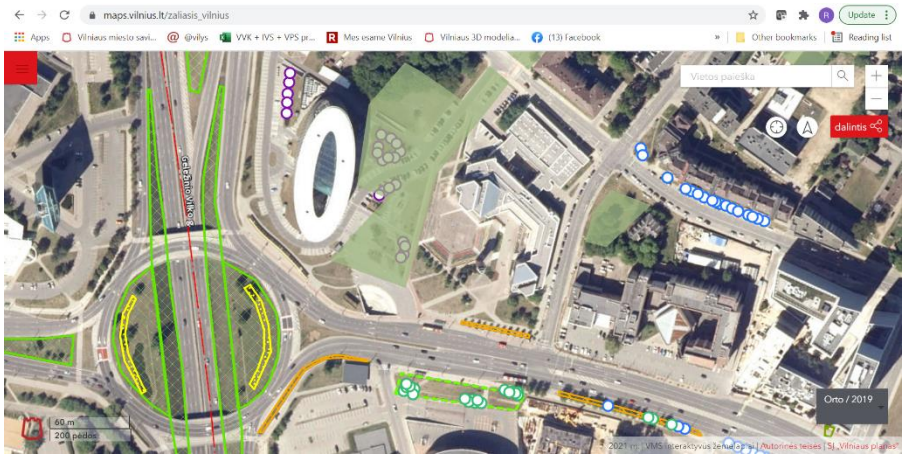
*"Although Vilnius is one of the greenest capitals in Europe with its parks, forests and alleys, many of these areas are remote and more difficult to reach, and everyone wants a green corner near their homes. Such green islands, I hope, will not only renew and beautify the living environment, but also become new attractions, charming accents of the district,"* said Vilnius Mayor Remigijus Šimašius.

### 4.3. GREEN WAVE

Nowadays the huge attention is taken to the city resilience to climate change – every year the city of Vilnius is planting new trees and bushes not only in parks and squares but along the streets to create shadow, collect rainwater, reduce hard coating of streets. 2185 trees and 8000 bushes were planted in 2020 [282].

The Green wave is sweeping through Vilnius as the capital's Municipality has set an ambitious goal, within the next two years, to make all the city's streets greener and much cosier. More than 100,000 trees, 10 million bushes and 300,000 climbing vines will be planted in Vilnius within that period of time. The Municipality administration calls all the residents of the city, the municipalities, entities and organisations to join this ambitious campaign.

Open data on green wave plans is widely accessible on green city map. On this map citizens are informed where and when new trees and their species are going to be planted. Everyone can find undergrows layer of shrubs, creepers, where the city implies sustainably mowed meadows, perennial flower beds and other important information on planting. The map contains different private initiatives. e.g. donating city with plants, field works and funds required for more explicit greening of the city public spaces.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workplace or in selected places of the city, for which Vilnius municipality provides all kinds of assistance and specialist consultations.

The arsenal of seedlings to be used in the Green Vilnius wave includes a range of plants tested as well rooting in Vilnius, adapted to the Lithuanian climate and urban conditions: maples, lindens, acacias, pines, spiraea, syringas, sorbarias, ivy and other creepers. The decisions regarding the method and the sites of planting are selected based on an essential principle – simplicity is the foundation of elegance and cosiness.

One of the more challenging and the first Green wave projects is the reconstruction of the Konstitucijos av., by arranging a green tree aisle while retaining the current number of traffic lanes. Intensive landscaping works creating street greenery traditions are also planned in the currently built new or rearranged existing streets. This street standard will be presented shortly. There are total about 2,000 km streets in Vilnius.

Every resident can find the scheme how and where to plant trees, bushes, flowers and even vegetables or various herbs. Contact e-mail is available for consultations (see below the picture):

Since October 2021 the Municipality is inviting residents, Municipal employees, and all volunteers to various areas of the city where the new greeneries planting will take place. These type of events have a very important and positive impact not only for the improvement of the green tissue of the city, but also for the uniting the communities. It is very important to stress, that GREEN WAVE will be stronger than the new wave of COVID, which looks very dark today.

### 4.3.1. First urban forest was planted

In the end of October the pilot biodiversity Urban forest was planted in the territory of Ozas residential area. Fostering the forestry traditions existing in Lithuania and this example aims to encourage the public to think about sustainable alternatives to afforestation of urbanized Vilnius city spaces. More than 700 trees were planted. This forest will be enjoyed by city residents for several generations.

### 4.3.2. Konstitucijos avenue will be greener

One of the goals of the Green wave is in 2 years to turn all the city's streets green and more cozy. Since October 13 in the main avenue of the city, named Konstitucijos, preparations for planting are going on. Here the greenery will separate not only the carriageway and footpaths, but also, in some sections, the opposite lanes. All municipal employees are invited to come on October 30 and join the action of planting the greeneries. Video link - https://www.youtube.com/watch?v=Y4dwouXzhNw.

The above mentioned actions and initiatives are extremely important today – in the situation when people are less active have more negative emotions because of pandemics. The city policy is oriented towards satisfaction of citizens' needs for best quality of life and prevent negative consequences of climate change and pandemic situation with consequences on life habits. Simple, bus very effective tools - physical activity together with colleagues and neighbours in the safe open space environment, will make better people 's mood, their emotions will be more positive after the performance of such a good job, as planting greeneries.

### 4.4. COMPLEX „ZIRMUNAI TRIANGLE" RENEWAL PROJECT AIMED AT REVITALIZATION OF URBAN INFRASTRUCTURE AS WELL AS OPEN PUBLIC SPACES

One of the important facts of the COVID-19 pandemic - citizens mobility was reduced due to the work from home, fear to use public transport, to travel to crowded public parks or squares far from the neighborhood "just to be on the safe side". In such a reality it was extremely important to have sufficient quality of public realm just very close to your living place – with possibility to spend your leisure time nearby your house.

Research in urban development practice shows that public spaces and green urban infrastructure are of paramount importance to people's health and mood. The measures and project we are presenting below already before the pandemic were important for achieving the goals of sustainable development and increasing the quality of living environment in the modernist and post-modernist neighborhoods in Vilnius. Those neighborhoods are inhabited by more than 70% of total population in Vilnius therefore today they are of a special significance in the fight against the pandemic.

Though Vilnius is a green city, some densely built-up areas of 60 – 90 are worn out, lacking quality of greenery, public spaces, recreation and playgrounds, and services. Due to the high number of cars and traffic on local streets, people in the yards are suffering from pollution and noise.

The case study of Zirmunai triangle (2013-2021) illustrates the possibility to convert the worn out living district planned according the modernism urban concept into the cozy residential area, where residents can clearly distinguish typology of space - find public areas for families, youngsters and retired to relax actively and passively same as courtyards where they enter buildings, park cars, maintain small flowerbeds and other greeneries on the "owner's meter" next to the building. Developed public infrastructure in the neighborhood gives residents' all qualities they might be looking for with no need to travel into the other part of the city. More than that – the satisfaction of the living environment improves the physical and emotional status of every resident.

On average, two-thirds of the urban population lives in apartment blocks, majority of which were built in Lithuania before 1993. At that time we were dramatically lagging behind European standards in accordance with the amount of living space per person, we did not have a rental housing stock, besides, residential houses and their environment were not administered effectively and people living there didn't feel in charge of maintaining space with owners' care. Modern city dwellers felt the absence of more contemporary space and housing planning standards.

Renovation of multi-apartment houses is one of the best explored tools to update the exterior and engineering equipment of houses, reduce energy consumption and living cost for residents. Though considering overall the renovation will not fundamentally change the quality of living environment: outdated layout of rooms; small kitchens; no elevators in 5-story buildings and limited accesses for elder and disabled, lack of storage space for bicycles, ran down staircases; unsecured entrances with limited access and visibility; dull and non-aesthetic facades; low energy efficiency; lack of parking spaces in courtyards; overgrown and undermanaged greenery; security issues in communal space outside the blocks of flats due to limited lightening and overgrown trees and shrubs, lack of equipped space for communication or entertainment, sports or playgrounds; uneconomical and monofunctional use of space.

97% of flats in multidwelings in Lithuania were privatized in 1990-1995, though common space in and around considered as nobody's that in a long run has induced feeling of lost identity and belonging and lack of ownership feeling. Massive privatization challenged renovation process and mistrust in public authorities. The large housing estates designed more than three decades ago, lack many qualities but on the other hand social services, such as schools, kindergartens, medical care institutions and engineering infrastructure were of good supply. Moreover, almost no urban capacity for contemporary real estate development limited opportunity for newcomers to the area and certain neighborhoods became locations where criminality and social segregation had started to flourish.

At that time Vilnius City Municipality has been looking for innovative techniques for integrated neighborhood renovation. Land stock under all large housing estates was and still is owned mainly by the State of Lithuania and distributed by dedicated national body. City of Vilnius doesn't own any land in neighborhoods for public or private initiatives, therefore in every case of renovation, new construction or upgrade of infrastructure city must acquire permission from State. Communication with national land supervisor takes time and is accepted with certain level of disbelieve. Under this circumstances renovation process might be postponed with unlimited time perspective. Complicated and bureaucratic procedures of land use are applied to owners of blocks of flats and obviously they are not proactive in taking over the land under large housing estates and acting as real hosts there.

City set strategic target to essentially improve image of large housing estates and to foster inhabitants' feeling of satisfaction, belonging and involvement. During the last decades a lot of things have already been done: an integrated neighborhood renovation programme has been launched and managed by newly established municipal company "Let's renovate the city"; standardized projects for buildings renovation have been developed and large consultation campaign with associations of flat owners has been started; urban plans of land plots designation for blocks of flats and public spaces have been prepared; new children's playgrounds and sports fields have been installed; ways to improve the quality of social infrastructure and parking have been searched. The efforts made by the Municipality have

already produced tangible results – according to the European Economic Forecast, by the year 2030 Vilnius will retain a stable population.

At the same time, in 2013 Vilnius Municipality joined the project "RE-BLOCK - REVIVING HIGH-RISE BLOCKS FOR COHESIVE AND GREEN NEIGHBORHOODS", that had been financed by URBACT II program. The main objective of the project was to foster efficient regeneration of neighborhoods, making more attractive and improving their environmental quality, whilst creating an integrated tailor-made approach to combat poverty. From the today's COVID prospective these objectives remains highly relevant. Participation in the project Re-Block was a great opportunity for Vilnius to use the international experience, look for models of complex renovation of residential apartment blocks, and promote their integrated socio- economic development. The models that were developed on the principle of the exchange of experiences included physical and social development of the regions, as well as their more efficient administration.

### 4.4.1. Best practice examples from EU cities – partners of Re-Block project

RE-Block project was committed to find new, innovative and smart solutions to face the challenges which were related to:

- The co-habitation of different cultures and ethnic groups resulting in social segregation and territorial detachment;
- Disintegrated and fragmented population, low level of initiatives for creating cooperating neighborhoods and communities;
- Low/destroyed infrastructure facilities, poor public spaces;
- High community bills due to the lack of energy efficient solutions;
- Few and not appealing community buildings / space for community events to facilitate human contact and social integration;
- Local authorities do not possess neither policies / tools nor experienced workforce to handle effectively these engraving problems.

The rehabilitation of deprived neighborhoods became a top priority topic in many cities all over Europe, More and more people living in these buildings are facing serious financial problems being unable to pay their rent and utility bills. As such they are getting "stuck" in this living environment. Vilnius has learned and studied the best practice examples of segregated districts rehabilitation from :

- Budapest, 18th district (Hungary)
- Iași ( Romania)
- Södertälje (Sweden)
- Magdeburg, Gelsenkirchen ( Germany)

Budapest, as the Lead Partner, started to built up the RE-Block network based on the need to find new tools and solutions to give a boost to rehabilitate the "Havanna" high-rise block building estate, a deprived urban area situated at the outskirts of 18th district of Budapest. The population of the district is around 100,000 and the "Havanna" housing estate, having a population of more than 17,000 people with low income and social status. The integrated social city rehabilitation of the Havanna high rise block buildings was launched already in 2007, however, there were still substantial challenges to be solved. The public authority owned only a low percentage of the dwelling, thus public-private cooperation needed to be established with (public and private) investors to make rehabilitation financially feasible. On the other hand, the involvement of citizens was a key to carry out a sustainable rehabilitation process. Also, parties needed to define sustainable and viable level of physical refurbishment using economically and technically up-to-date methods. The Lead Partner together with other partners, including Vilnius, carried out the rehabilitation taking into account leading and tendency-building examples in Europe, where the city combined the use of an integrated approach, financial support, and participation of inhabitants)

Vilnius has chosen the pilot area for the project Re-Block - the part of Žirmūnai district, the block between Minties, Žirmūnų and Tuskulėnų streets, hereinafter referred to as Žirmūnai triangle. In consultation with the local community, entrepreneurs, public organizations, and politicians a Local action plan for the neighborhood has been developed, and later, Progressive management guidelines were produced, suitable as well for other problematic residential areas requiring renovation. In order to bring a fresh breath into Žirmūnai catchment, it was necessary to provide more diversity to the area so that can attract people of a wider range of social classes and ages, build a united and socially responsible community, which could eventually lead to different lifestyles.

The neighborhood was selected also because of perfect strategic location, convenient connection with city centre. At the same time the neighborhood was facing the major problems:

- Built more than 60 years ago, lack of identity and character;
- Aging neighborhood;
- Worn out infrastructure;
- Lack of clear urban/traffic structure;
- Lack of parking – 53% of required;
- Low quality of greeneries;
- Safety problems;
- Worn out play grounds, furniture.

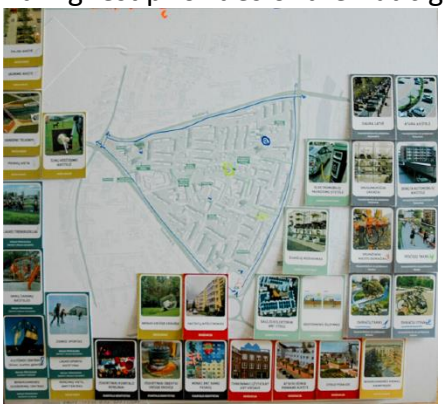
## ŽIRMŪNAI TRIANGLE - pilot territory

| Territory | Density: | Total residents: | Ethnicity: |
|---|---|---|---|
| 52ha | 243 residents / ha | 12 000 | 60% lithuanian, 17% russian, 14% poles, 9% other |
| 25% built area; 20% roads and infrastructure, 55% open and green spaces | | Average age: 51 – 65 | |
| 3660 apartments built during 1965-1968 | | 2 Km to the old town center | |

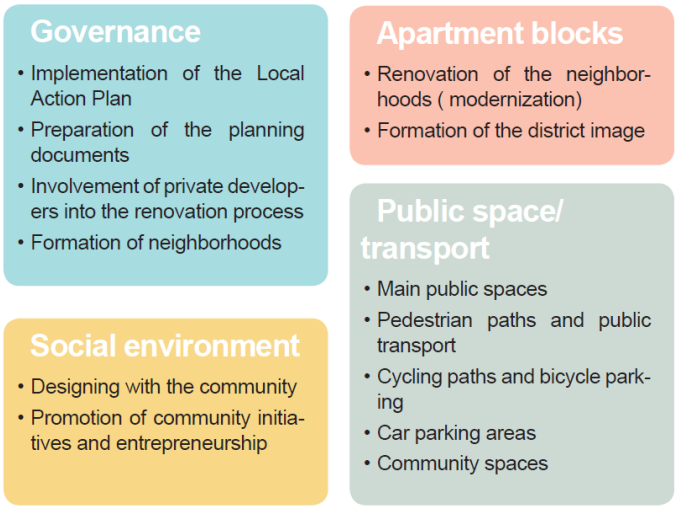
### 4.4.2. Public participation process

During two years (2013-2015) Vilnius Municipality, external urban planners, residents of the "Zirmunai triangle " had been working together very closely on the development of the Action plan. The cooperation of all members of the working group helped to achieve an outstanding result. The group consisted from residents, NGO representatives, teachers and students, Universities representatives, politicians, SME'S.

Creative workshop methods were used in order to find out what are the initial needs and wishes of the district from the residents, business, and public bodies point of view. 3 scenarios were developed based on results of urban analysis and highest priorities of thematic groups.



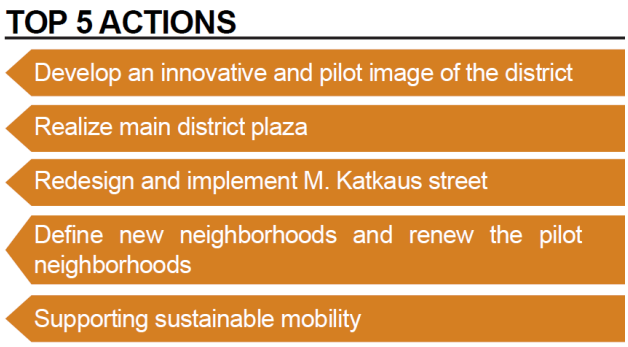
### 4.4.3. Urban vision




- Public spaces. Improved public spaces are linked into a network. New green district plaza is designed; M. Katkaus street will be for pedestrians and cyclists; wide paths are formed along the main district streets; renovated and lightened entrance route to school; pocket public spaces nearby public library and youth centre.
- Green courtyards, attractive residential environment. Courtyards with maximum of greenery and minimum of car parking infrastructure. Apartments on the ground floors get new entrances straight to the courtyards.
- Neighborhoods. Division into smaller districts – neighbourhoods aprox. 1000-1500 residents These communities will be in charge of maintaining their courtyards, playgrounds, meeting spaces, car parking. The division is based on spatial organization of existing buildings.
- Sustainable mobility. Walking, cycling & using sustainable modes of transport. Slow mobility paths connect all important functions with the district and the surroundings. Bicycle parking racks and sheds are planned next to shopping malls, school, public institutions, and apartment blocks.
- Public transport. Increased use of public transport - better links from apartments blocks to public transport stops. Routes to the stops are clearly marked and lightened. Stops areas are enlightened, equipped with WiFi, new functions are encouraged.
- Reduced car traffic. Traffic is reorganized by avoiding car transit. Parking facilities are solved inside neighbourhood individually. Other part of parking is provided along the main streets, next to the

public objects. District regeneration process starts with implementation of pedestrian and cycling paths first.

- Links to river Neris. River Neris is the most popular recreational destination among the residents, therefore new links are formed to connect Žirmūnai triangle with the park along the river. Design of safe pedestrian crossings and clear route marking.




### 4.4.4. From URBAN VISION and prepared ACTION PLAN towards the implementation

The project Re:Block finished in 2015. Since that time the further actions were taken by the administrative staff of Vilnius Municipality in order "to make the dream true" – to start the real implementation of the foreseen actions. The most important further step was to include the prepared Action plan of Zirmunai triangle into the Integrated Territories Development Program of Vilnius city. Partial financing from the EU funds was an absolute necessity. New project aimed at increasing attractiveness of Žirmūnai Triangle and revitalization of urban infrastructure as well as open public spaces to be financed by ERDF; Total budget - 5.101.942 EUR (EU - 4.336.651 EUR, Municipal - 382.646 EUR, State - 382.646 EUR) After the long bureaucratically process The Ministry of Internal Affairs has approved the project and "green light" for the further design planning was given. The whole process of planning and designing was carried out by Vilnius municipal company "Vilniaus planas" It was widely disseminated; frequent meetings with community was taking place in Zirmunai living district. The great attention was taken into the expressed needs of residents as they have represented all age groups. Decisions, that had been made in 2017-2018 - today have a very significant role and are extremely relevant taking into consideration current COVID 19 lockdown. The final project was ready in 2019. The most important idea of the project – contemporary design of public spaces brings new quality of life, boosts spirit of satisfaction and attachment to the place and creates modern identity of large housing estate.

Couple of years ago the construction stage was started and today local inhabitants might experience the outcome of this project. Explicit network of recreational pedestrian and cycling paths is constructed, sports and active recreation grounds are installed. New lighting system created, that brings an essential improvement in the safety issues. City furniture, underground garbage collection system with recycling capacity is installed, large number of trees and shrubs planted around the housing estates. New Main Square with modern lighting, space for events, several functional zones that are formed and distributed throughout the territory: quiet recreation areas with seating, children's playground for children under 12 years of age.

The project aims to renovate public realm. Our task was to support and promote not only physical renovation but to boost local spirit by creating specific objects or structures: landscapes, landmarks, arts, traditions, events, that attract the local people to enjoy their extra hours for recreation during the COVID period. During the unstable times and non-finished COVID partial lock downs is extremely important to guarantee the citizens possibility to have sport facilities near by your place of living. It serves not only for teams (playing basketball etc.), but also open for all solo users of sport equipment - both for young and senior citizens (see illustrations below).

### 4.4.5. Žirmūnai triangle project with accordance to Vilnius city strategical documents

Vilnius City Council approved on 2 June the new **General Plan (GP)** of the Lithuanian capital, along the lines of which the city will live and develop for the next 10–15 years. What the strategic blueprint boils down to is that Vilnius will become more convenient for pedestrians and cyclists, there will be more green areas, and the height and quality of buildings will be more strictly controlled.

In the general plan, the main strategic directions of the city's development have been laid down: sustainable mobility, comfortable residential areas, development of southern Vilnius. This means that in the future, a lot of attention will be paid to the establishment of more stringent architectural rules and street standards.

The General Plan also reflects the principles of the City + programme which include development of green spaces, modernization of residential areas, focusing on sustainable mobility and development of social infrastructure.

The Strategic plan of Vilnius City for 2020-2030 was approved by the city Council on July 14, 2021. One of the goals – to seek the improvement of the living environment.

Quality of life should not depend on the district. To this end, the aim is to raise the quality of life in Vilnius sub-centers in a coordinated and comprehensive manner. Strategies that will be developed specifically for each district will be aimed at comprehensively raising satisfaction with the living environment by increasing access to housing and the creation of multifunctional districts / centers where access to services and cultural activities will be ensured.

### 4.4.6. Results and conclusions

In the today's situation of the ongoing COVID crisis the general aim of the Project „Zirmunai triangle" remains very relevant - minimizing the influence of Coronavirus and negative emotions in a built environment by applying behavior change. For a couple of years Vilnius municipality is specifically oriented towards the increasing of citizens wellbeing. It is important to stress, that in addition to the economic growth of Vilnius, there is also an emotional side of residents, which must be purposefully compatible with the city's policies, development and everyday life. In the implementation of policies of the city, the development of mental and physical health enhancement services and locations has been purposefully conducted in parallel to promote wellbeing of residents of Vilnius based on the needs that have already been identified. Satisfaction of the close living environment, positive emotions, possibility to have a quality leisure and active sport time nearby your dwelling – these are achieved results of the implemented pro tives to motivate people to be physically active and eat healthy, using open spaces of the city, involving businesses and NGOs, and providing services closer to a person.

## 4.5. VILNIUS HAPPINESS INDEX

According to a survey published by the European commission statistics Agency Eurostat, for the third year in a row Vilnius has the happiest number of people (94 %). Vilnius citizens' satisfaction with the quality of life between EU capitals is evaluated: Air quality 69% (10 place); Noise level 76 % (7); Green spaces 78% (6) [297]. No doubt that a pleasant, aesthetic, healthy and resilient urban environment is important for the quality of life.

Vilnius attempt to be among the happiest places to live in the Europe, is incorporated in to the political program 2019 -2023 „To Vilnius, which we are proud of", Vilnius City 2021-2030 strategic development plan, as well into the strategic direction Vilnius2in.

What makes Vilnius citizens to be happiest and satisfied with living in the city? The answer is an integrated environmental and emotional issue.

Nevertheless, COVID-19 pandemic forced city managers to rethink traditional urban planning measures dedicated for the socio-cultural activities, health, economy, deliver more public service online, make the city greener, keep social distance, and ensure access to information.

What if we can measure the Vilnius happiness index in an innovative way? Through the ROCK project (2017 -2020) Vilnius city administration went a step further for intellectual city. By using Multimodal Biometric Method emotions where collected from 10 sensors analyzing the emotional, affective and physiological states,

arousal and valence (MAPS) of passersby, is a quantitative and qualitative understanding of people's feelings. For evaluation of the quality of services additional sensors were installed in the City hall, on the public beaches, during massive city events [298].

During COVID19 Quarantine, the Sensors showed the dominance of negative emotions. City administration was very active to inform citizens about health security, purchase masks and other equipment needed, and developed a support plan for pandemic victims. After a partial release, positive emotions rose higher, but boredom prevailed. Therefore, it was decided to organize various cultural and business events (cafes in open spaces, concerts in the Old Town, Films at the airport, etc.). When the lock down ended, the mood of the population returned to average and dramatically fell down during the second lock down in December 2020, Figure 4.11. To perform with neuro analytic data and its protection requirements takes specific knowledge [298].

Strong technological and scientific partners from VGTU help to implement such experiments and, in the chart, we can see how the happiness index changes due to Covid conditions [298].

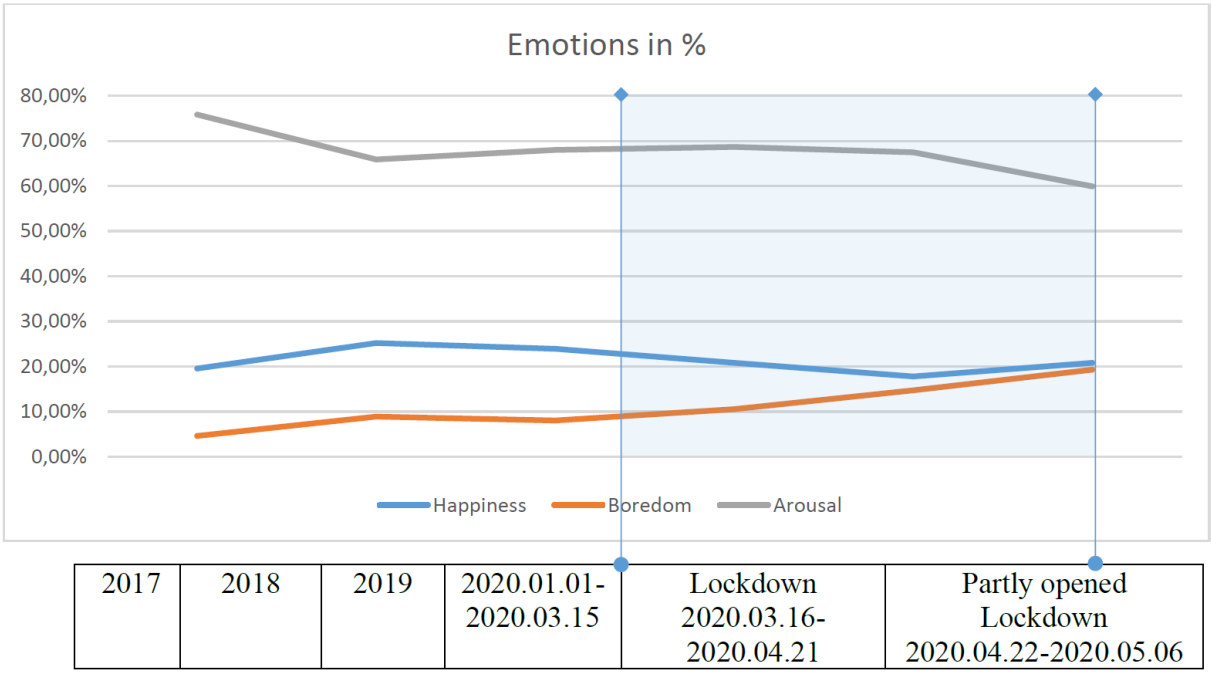



**Figure 4.11.** Emotions monitoring from 2017 until 2020 partly opened lockdown in Vilnius [299]

Another thing is that during lock down from 2020-10-28 until 2021-02-25 wearing a face mask in open spaces was mandatory. According to these circumstances the happiness index fell down dramatically because sensors cannot normally identify emotions from faces.

### 4.5.1. Overwiev on strategical path

In 2020, the City of Vilnius committed to a long-term innovation development plan that is outlined in the Vilnius City Strategic Direction VILNIUS 2IN (Intelligent and Integrated). This umbrella vision covers 10 fields of governance (i.e. mobility, environment and urban planning) and is supplemented by an all-encompassing concept known as the City as a Lab, which aims to shape the city's actions and working methods by giving officials and city stakeholders enough room to experiment and learn by doing [300].

Vilnius 2IN was drafted in accordance with the city's operating strategy until 2030, as well as other legal acts and normative documents governing activities in Vilnius, and the observance of the World Economic Forum's Digital Transformation Initiative and best global practices. To ensure it complies with the world's best performance standards, this direction will be reviewed and updated at least once per year. Highly driven by experimentation, this direction offers flexibility and enables the entire city's ecosystem to foster change and develop innovative solutions to maximize returns to consumers, which is the end goal of Vilnius 2IN. This

direction was developed taking feedback and proposals made by city residents and employees into account. Moreover, Vilnius 2IN is binding to groups of companies subordinate to the City of Vilnius. This means that all internal normative documents governing or related to the Vilnius 2IN must be approved by the Head of the Vilnius City Administration and align with the provisions of this direction. This broad application will enable city stakeholders to play an active role in initiating projects and new practices, and helps ensure Vilnius' actions are coherent and dedicated to fostering innovation throughout the city.

The implementation of VILNIUS 2IN has been delegated to the Vilnius City Administration by direct appointment of project managers as well as the programme and portfolio managers supervising them. City-subordinate groups of companies implement the Vilnius 2IN strategic direction through strategic plans, letters of expectations or performance indicators, and delegate to managers and boards to ensure the integrity of the strategic direction through the goals they set.

The strategic direction of Vilnius 2IN put forth a vision for the city in the area of digitalization. It foresees the common goals and tasks that this area is subject to, their connection to the city's strategy and activities conducted in the area of digitalization, and the main principles of performance of the activities – while following the initiatives of an intelligent community using information and communication technologies to create inclusive prosperity – solve social issues and enrich people's quality of life. VILNIUS 2IN is not constant – it needs to be reviewed and, if necessary, updated at least once per year to ensure its compliance with the goals of the City of Vilnius and its subordinate companies, as well as legal acts, advanced global practices and best performance standards.

The strategic direction of VILNIUS 2IN-related programmes and projects follows six operating principles:

1. Management practice of international activity – best international activity management practices.
2. Overall Knowledge – ability to digitize, share and build on existing knowledge.
3. Innovation – application of advanced solutions aimed at turning results into practical benefits for all stakeholders rather than being self-directed.
4. Digital Equality – all community members deserve access to technology and equal opportunities to use them.
5. Intelligence Excellence – an intelligent community adopts technology but is focused on a vision and a reasonably convenient method of use aimed at resolving current urgent problems rather than focusing on digitization.
6. Advocacy First – publication of initiatives, activities and results among all members of the community to attract as many initiators, advisers and users as possible.

The implementation of VILNIUS 2IN has been delegated to the Vilnius City Administration by direct appointment of project managers and the programme and portfolio managers supervising them. Groups of city companies implement the direction outlined in Vilnius 2IN through strategic plans, letters of expectations or performance indicators, and delegate to managers and boards the assurance of the integrity of the strategic direction through the goals set out in it. The strategic direction is financed according to budget-specific programmes and projects pursuing integral coherence.

To monitor Vilnius' success and progress, a simple but robust and innovative key performance indicator (KPIs) system was implemented, allowing them to ensure a consistent direction of the entire ecosystem, performance results and progress. The KPIs allow for the pursuit of:

- Integrated development goals
- Becoming a digital and intelligent city
- City as a Service.

**Figure 4.12.** City indicators

Three KPIs define the city's ambitions [300]:

1. Happiness Index (measured as a relative value)
2. Travel Time Index (measured as relative value)
3. Life Expectancy (measured in years).

These indicators themselves do not suggest any specific way to reach them but are the ultimate results by which Vilnius measures its success. When brainstorming a new initiative, a new project or solution – will it positively contribute to these indicators?

### 4.5.2. Situation analysis of impact on real cases

#### a) Vilnius City daily life sensors

The strongest emotions of passers-by captured by sensors and special lamps in 8 locations of the capital [301] are evaluated and presented as a summary of the expression of happiness of Vilnius residents on the website [302]. If there are no vacationers in the area being measured at the time, numeric readings do not change.

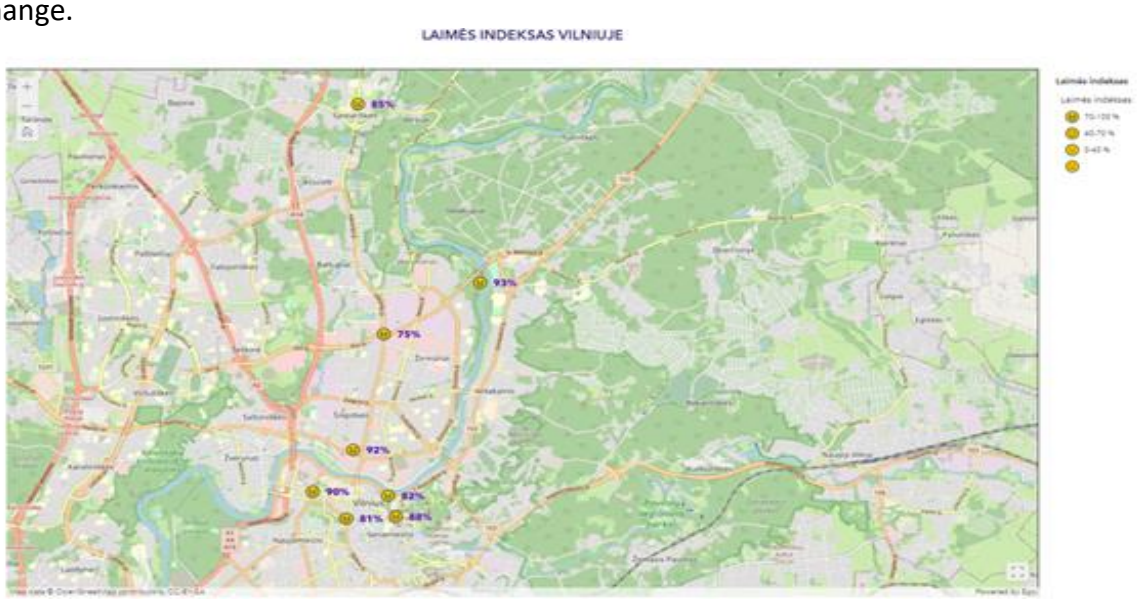



**Figure 4.13.** Location of the sensors [301]

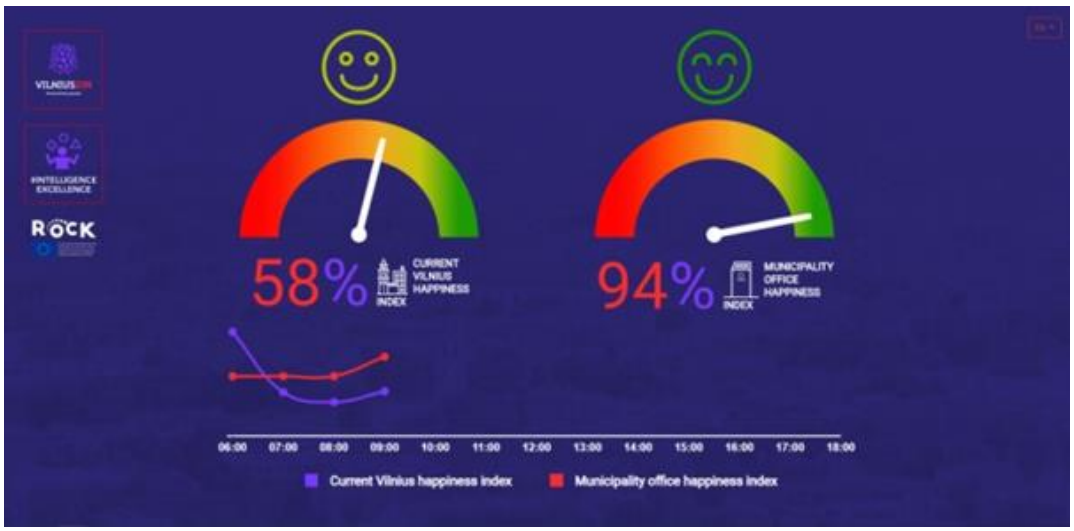



**Figure 4.14.** Vilnius Happiness Index [302]

The neuro-analytical system created by VGTU and the City of Vilnius is designated for collecting and analyzing anonymized emotions of residents, their affective and physiological states in public spaces by including additional data and combinations of layers of information, which will subsequently be used to create emotional, affective, physiological and pollution maps of public spaces (in light of the circadian rhythms of the day and the week, gender and age of people) and to provide personalized recommendations.

Big data, gained for the Happiness Index (HI), is used for other purposes (urban planning, heritage, cultural events, COVID19, etc.). Such a revolutionary service/tool is under development, could be commercialized, because it takes time, requires specific skills, budget, etc.

Neuro analytic is a multidisciplinary tool, more effective than traditional surveys or meetings, facilitating „to move cities progress from bottom to top".

Success factors of initiative: Vision, political support, brave administration, budget, skills, as well – city administration, scientists and business partnership.

System analyses and rates residents valence, arousal and emotional states (happy, sad, angry, surprised, scared, disgusted or a neutral state), affective attitudes (boredom, interest and confusion) of passers-by and their physiological states (temperature, heart rate, breathing rate, etc.). These affective, emotional and physiological maps serve as references that can offer stakeholder groups personalized tips for upgrading the cultural heritage for greater efficiency and sustainability.

This use of open data and neoanalytic technology for measuring citizen's wellbeing is highly transferable. While particular solutions reached are generally specific to Vilnius, the creation of an innovation environment where entrepreneurs and cultural actors are empowered to enrich the city is bound to produce results for any municipality that embraces it. The open data policy is generating great returns for the city and can sustain itself into the future. Currently, the municipalities of Bologna and Lisbon are introducing this initiative.

In the situation when pluralism is dominating, innovative neuro-analytic tools can give objective answers, help to evaluate and measure situations in real time, about real people's needs and opinions.

In the project, Vilnius combined technological innovation with an everyday/moment phenomenon - emotions, enabled politicians to make decisions using these results, and technicians to use them as open data. This is what Vilnius can share and teach others.

Human interaction should be facilitated by urban planning, which is why the Agenda calls for an increase in public spaces such as sidewalks, cycling lanes, gardens, squares and parks. Sustainable urban design plays a key role in ensuring the livability and prosperity of a city.

**b) The impact of the quality of services on citizens emotions**

Vilnius SMART BEACH was implemented as a pilot project. Already 2 years in a row during summer season smart sensors had been installed and used for measuring air, water temperature and people emotions in 3-4 main Vilnius beaches as well as implemented 3rd party's solution for monitoring occupancy of the beaches using telecommunication company provided data. Collected and aggregated data is provided with graphical safety announcements in the screens installed at the beaches locally. Air, water temperature, emotions, beach occupancy information also represented in the web VILNIUS ILSISI as well as other information regarding services which you can find at the beach, public transport routes, problem registration platform which helps for people to plan free time and activities, feel safe and satisfied.

**Figure 4.15.** Vilnius SMART BEACH

According to different information data sets, it's possible to monitor and understand the phenomenon of which event or how public services have an impact on the citizens' emotions. It enables us to make data driven decisions and monitor what results achieved after change is implemented.

For example, during the 2020 summer at the largest Vilnius Lukiškės square an artificial beach was installed. Beach holidays during a pandemic is a luxury with limited availability. However, an open beach in the city's largest square can provide a similar feeling without travelling far.

People need to socialize. They also need the sun. And a beach. And a sea. And when it is not available, people will find ways to bring it to themselves (Fig. 4.15).

The Vilnius City municipality teamed up and did just that. The result – an urban beach with white sand, wooden paths, sun loungers, a lifeguard tower, changing booths and a giant screen with sea waves and sounds. A real beach holiday feeling in the city, which is located 3 hours away from the seashore.

**Figure 4.16.** Vilnius OPEN BEACH

The emotion reading sensors were installed in a square area and they showed awesome results. The chart below shows more happy and less angry emotions (purple) in the Lukiškės square compared with the overall Vilnius same two emotions (yellow).

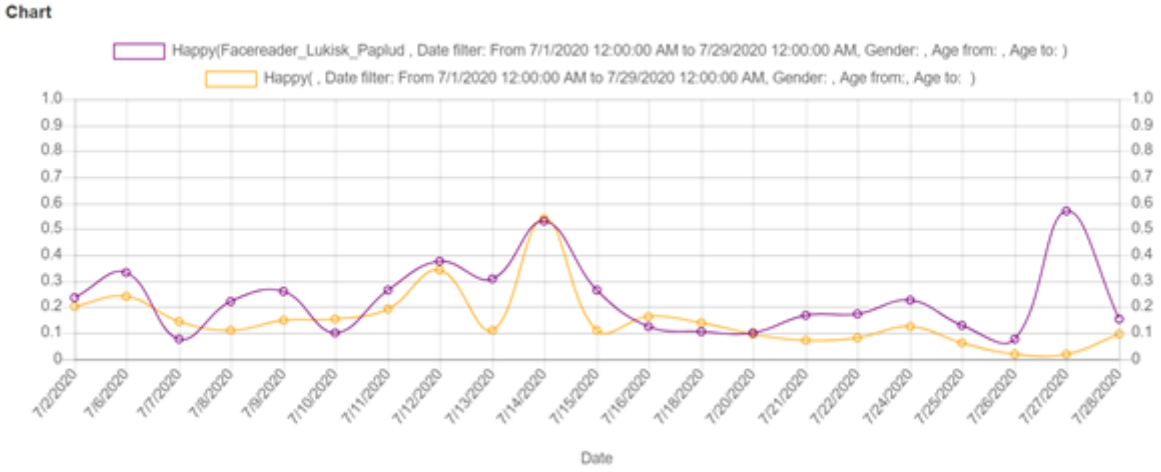



**Figure 4.17**. Vilnius OPEN BEACH happy (source: VGTU data, September 2020)

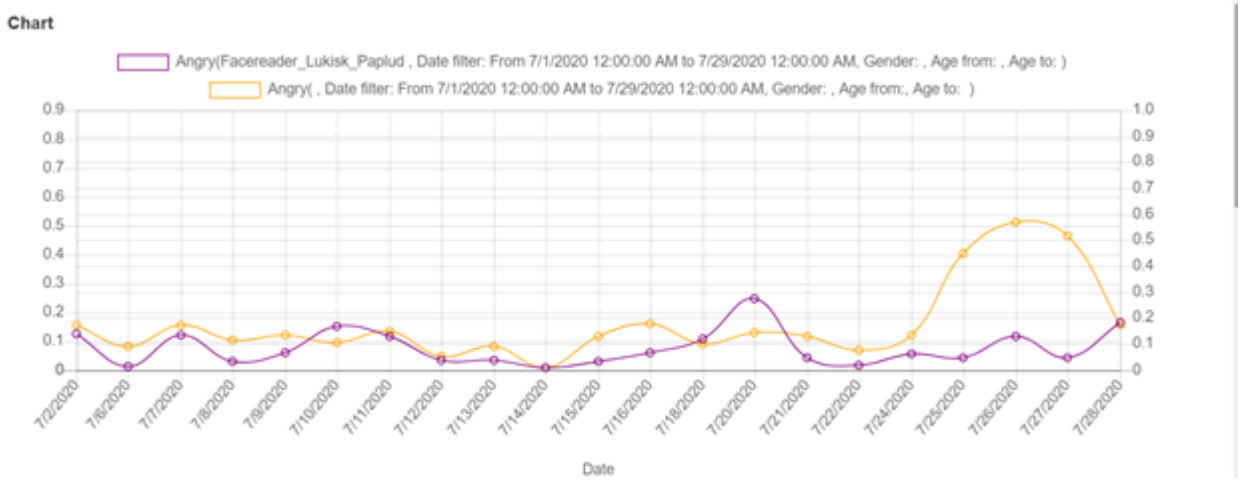



**Figure 4.18**. Vilnius OPEN BEACH angry (source: VGTU data, September 2021)

Another use case implemented at Vilnius City municipality main hall from 2019 is to measure emotions in Vilnius City Customer service and show happiness index results in competition with overall Vilnius City happiness index. This feature enables city managers to monitor how clients - citizens feel and how public services can be improved to achieve higher positive emotions. Additional things such a coffee smell and visual installations were installed after 4 months period to understand what direct impact have environment to the visitors emotions.

**Figure 4.19**. Vilnius City municipality main hall [302]

These use cases enable us to gather and evaluate the information about different environmental factors, changes in the city, public events which interact with citizens' emotions and allow effective planning and policy making.

**c) The impact of cultural events on the citizens emotions**

Real-time mapping, based on this neuro decision table, is needed to display the affective attitudes, emotional and physiological parameters of people passing through the cultural heritage. These affective, emotional, and physiological maps serve as references that can offer stakeholder groups personalized tips for upgrading the cultural heritage for greater efficiency and sustainability [303]. Big data collected from neuro - analytic sensors and analysed on a daily cycle, every 24 hours. It shows when people are the happiest, when they are bored or tired, how much the level of happiness [298] depends on season, humidity, wind, weather conditions, pollution, temperature, magnetic storms or the daily rhythm. The emotions rise during the cultural events, fears, in the more aesthetic of surroundings. People are less happy at high wind speeds, under magnetic storms.

These affective, emotional and physiological maps serve as references that can offer stakeholder groups tips for upgrading the cultural heritage for greater efficiency and sustainability.

One of the challenges was enthusiasm to implement – Opinion survey for measuring the social impact of cultural - led projects (especially related to the process of closing key streets in the historic centre and upgrading the lost Great Vilnius Synagogue area), by measuring opinions and preferences of citizens, tourists expressed through social media channels. The tool was tested as a pilot action. Rock Vilnius working group decide to postpone the experience until the summer of next year.

Light festival initiative supported by creative PR process (TV, Radio, scientific journals, etc.). In addition, IT and lasers company" Opotronika", NGO „Vilnius light festivals ", Municipal lighting enterprise launched a system to interpret the data into colors. During the light festival, the city's birthday celebration event (January 24 -26, 2019 – 2020) "colors of data" were exhibited in the most prominent cultural places – on the Hill of Three Crosses [304] and National Art Museum wall [305] [306]. Emotions stand was created for "Open day" [307], "Log in" event [308], in Brussels for R&D Days, etc.

### 4.5.3. Integration with Open data policy

To encourage openness, collaboration and sharing, which are key to Vilnius' long-term vision, the city started owning the idea of opening its data resources to the public. As a result, the open innovation – open algorithm – open data portal was launched in 2019. It provides easy access to data related to Vilnius and information on various projects developed by the city or third parties, using open data. While this helps IT specialists develop new digital solutions as they acquire already mastered systems codes and digital tools free of charge, the general population of Vilnius also has open access to high-quality data and statistics that can help them make informed decisions on various aspects of their lives [305].

Open Data not only allows for passive use of resources, it also encourages active participation of society, which in turn builds up a sustainable ecosystem that is mutually beneficial to all parties involved. With the aim of finding solutions to societal challenges, Vilnius connects city stakeholders and jointly runs hackathons using the open data portal. Throughout the years, this experiment has become a common practice to address the city's problems.

In Vilnius, as in many cities, pedestrianisation is often initially unpopular with local shop owners. This is because during the necessary road works, and for some time afterwards, owners can expect to see a reduction in revenues. However, the data shows that in the long term, pedestrianisation leads to significant increases in revenue. Gathering this data and showing it to businesses is a good way to reduce resistance to change.

All these tools and other ones are generating a lot of data. Vilnius open data policy means that data from the city, and also from the private sector, is available to the public. This data is fuel for an enormous amount of local innovation.

Residents are also empowered as data gatherers, with mobile apps like "Tvarkau Miesta", which lets them report issues such as overflowing bins in public spaces. This creates a direct line of communication between the residents of Vilnius and the municipality.

Beyond the wellbeing [302] and cultural economic stimulus enabled by data collection to a further value: transparency. Opening up data between the city administration and the public strengthens the relationship, and the trust between them.

The data relates to everything in the city, from energy consumption of the kindergartens, to traffic and public transport data, to data generated through theoretical models. The municipality also shares all the information about its finances, public procurement, real estate and public transport.

The inspiration for this move was initially sparked by a practical concern. It was getting a huge number of public requests for data, it was taking a lot of the time and energy of the municipal staff. Then we thought, what is the value for the municipality of being an intermediary that stands in between the people and this data? So we made it all available.

Municipal companies have also seen big benefits. Using open data and other good governance practices has increased their output capacities and reduced their costs. The municipal road construction company Grinda, for example, has increased its production rate by 40%, lowering the costs for customers by 20%. Want a good argument for open data? Just look at the data. [309]

### 4.5.4. Conclusions

- Gathering of the emotional data enables to reform/improve policy making and planning. We believe that positive emotions are an integrated assessment of the results that city leaders and urbanists seek when investing in and designing city public spaces.
- Evaluation of the happiness index enables to reform/improve of all internal and external City services. Knowledge how tangible and intangible environmental factors affects citizens enables city management data driven decision making. The emotions result during COVID19 shows that Vilnius City management responded adequately to the situation and the decisions made resulted positive citizens emotions.
- Publicly accessible data enables view of the living emotions and City management accessible data enables view of policy decisions and measured emotions outputs.
- City environment, events, implemented changes, public services enables businesses and institutions of the City to understand what impact and affect it had and may have to the citizens' well-being.

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