URBAN MOBILITY IN POST-COVID CITY: Assessing the Conflict between Safe and Sustainable Urban Mobility in Four Types of Neighborhoods in GCR Egypt

Associ. Prof. Dr. Islam Ghonimi
Department of Architecture, Shoubra Faculty of engineering, Benha University, Cairo
islam.ghonimi@feng.bu.edu.eg

Abstract:

Covid19 pandemic has given social distance great concerns in contemporary cities especially the one related to safe urban mobility. People were asked to choose travel modes that maintain safe social distance to minimize the chance of infection while traveling safely from one place to another. Accordingly, urban mobility witnessed a paradigm shift from the first sustainable urban mobility paradigm that found efficiency in mass transportation and minimizing the need for extended private motorized mobility inside cities, to the new safe urban mobility paradigm that strive for reducing the face-to-face contact by encouraging single ride mobility. Accordingly, Planners are required to shift to the new paradigm of urban mobility, and scholars are required to question health safety of the new paradigm of urban mobility at the same time to question its sustainability. The research aims to compare adopted movement behavior across different neighborhood models including purpose of mobility, mode choices, trip distance, and trip frequency. The paper reports, based on empirical findings, to three conclusions; Firstly, covid19 caused different levels of coping movement behavioral change across different types of neighborhoods. Secondly, the paper observed coping ideas of reducing unnecessary trips, displace mobility from public to private modes, distribution of trips to different times of the day, providing safe walkway for keeping social distance and encouraging walkability and cyclability. Finally, the paper deduced different design guidelines for urban form design that facilitate such coping urban mobility strategies and at the same time achieve sustainability including soft mixed use, soft density, and grid street patterns to facilitate coping of safe and sustainable urban mobility.

Keywords:

Covid19, Viral Spread, Social Distance, Coping Commute Behavior, Sustainable urban Mobility

الملخص:

أدى انتشار جائحة كورونا الى إعطاء التباعد الاجتماعي أولوية كبيرة خاصة في الأمور المتعلقة التنقل الحضري الأمن. حيث طلب من الناس اختيار أنماط تحرك تحافظ على تحقيق التباعد الاجتماعي لتقليل انتشار العدوى اثناء التنقل من مكان الى اخر داخل المدينة. وبالتبعية شهد التنقل الحضري تحول مفهومي من مهوم التنقل الحضري المستدام الذي يضع الأولوية لاستخدام المواصلات العامة وتقليل الاعتماد على المواصلات الخاصة داخل المدن الى مفهوم التنقل الأمن الذي يضع الأولوية لتقليل التنقل الجماعي وتشجيع النقل الفردي. بالتبعية وقع على عاتق المخططين التحويل للمفهوم الجديد للتنقل الحضري، وأصبح دور الباحثين هو التحقق من امن وصحة النموذج الجديدة وفي نفس الوقت مراعاة الاستدامة. وأصبح هناك تساؤل عن قدرة التصميم العمراني في الأنماط العمرانية المختلفة لتسهيل تحقيق كل من التنقل الحضري المستدام والأمن. لذا يهدف

البحث الى مقارنة سلوك التنقل في أنماط متنوعة من المجاورات السكنية بما تشمله من أسباب التنقل، اختيارات وسائل التنقل، مسافات التنقل، معدل التردد على التنقل. يهدف البحث بالاستناد الى النتائج العملية للتحقق من صحة ثلاثة نتائج أساسية أولا: التحقق من اذا كان لانتشار جائحة كورونا تأثير على ظهور مستويات مختلفة من التغير في سلوك الحركة في الأنماط السكنية المختلفة. ثانيا: ملاحظة افكار التكيف المختلفة مثل تقليل الرحلات غير الضرورية، تحويل الحركة من التنقل العام الى التنقل الخاص، توزيع الرحلات على مدرار اليوم، توفير مسارات امنة للمحافظة على التباعد الاجتماعي وتشجيع التنقل باستخدام المشي والعجل. أخيرا استنباط مجموعة من المؤشرات التصميمية للعمران التي يمكن ان تسهل سياسات التنقل المستدام والامن حيث تبين الدور الذي يمكن ان يلعبه التصميم العمراني التقليدي في توفير دروس لتعزيز التنقل الحضري المستدام والامن في فترات ما بعد كوفيد 19.

الكلمات المفتاحية:

كوفيد 19، التباعد الاجتماعي، سلوك التنقل الحضري الامن، التنقل المستدام، أنماط المجاورات السكنية.

1. Introduction

The first few months of 2020, the whole world faced the emergence of Covid 19 pandemic. During the COVID-19 pandemic, people were asked to stay home and to avoid face to face contact as a step for containment strategies. The short lockdown failed to give continuous solution that can last; Accordingly, most governments turn to the post-lockdown stage by taking precautions of social distance and reducing rates of occupation, where residents were asked to avoid close distance with people to prevent infection and to contain the spread of Covid-10 and asked to take some precautions to reduce infection including keeping 1m distance with others, using face masks, and alcohol.

In post-lockdown, people fear of virus transmission risks in travel modes caused a relevant impact on travel demand, mobility choices, trip frequency and trip time. A new paradigm shift in urban mobility is expected, that put social distance as a new way of life to prevent the spread of the virus. The old norms of public transportation are subjected to research, a paradigm shift from mass public mobility modes to new paradigm of single mobility modes aims to change people behavior to travel safely. Public mobility became unrecommended, even though it can achieve high sustainability issues, rather it failed to achieve social distance and safety. On the other side, single passive mobility like private car in one hand can provide safety from infection but at the other side it could reduce sustainability. A growing concern to single active mobility modes like cycling and walkability that can provide a safe social distance and at the same time achieve sustainability (Zafri, et.al. 2021).

Planners are recommended to support social distance as a norm for the quality of urban form even though it may cause emergence of unsustainable private modes that could impose longer travel distance with private mobility imposing high resource consumption and air pollution in front of sustainable public modes. Scholars are facing challenge of changing paradigm of urban mobility to be safer and, also to be sustainable. This paper considers how Covid-19 might influence people mobility behavior and in turn might shape future development in term of safety

and also sustainability. Different scholars discussed travel behavior change before and during the pandemic (Abdullah and Dias 2020; Anwari et.al., 2020; Zafri, et.al. 2021). Still the comparison of the impact of covid on travel behavior across different types of neighborhoods are not still covered. This research intends to fill this gap.

1.1. Research Problem

Covid-19 pandemic has raised concern for changing patterns of urban mobility to achieve safety even if it was associated with reduced sustainability. Urban form characteristics proved to impact urban mobility, travel behavior and mode choices (Ghonimi, 2017). Some urban forms can facilitate coping mobility to achieve health safety with regarding sustainability, other urban forms facilitate only coping mobility to achieve safety over sustainability. Examining travel behavioral change before and during pandemic across different types of neighborhoods give great recommendation of how efficient are each model in achieving balance between safety and sustainability. A misleading perception of promoting some urban forms for misguided reasons to support safe mobility could reduce concern to sustainable mobility without achievement of intended sustainability.

1.2. Research Hypothesis

The research assumes that covid-19 has moved urban mobility to more social distance and more crowd management. And that change from traditional to modern urban forms can facilitate or discourse such coping urban mobility change to safer mobility. It assumes that Covid19 results in varied movement behavioral change across different neighborhood types. The research argues that sprawled neighborhood is not corresponding to safer social distance, rathe it can lead people coping urban behavior not only to unsustainable urban mobility behavior but also to a less social distance, more occupation density, and more overcrowding that may increase spread of viral infection.

1.3. Research Aim

An understanding of the relation between urban form, urban mobility, at extraordinary situation like covid 19, will help not only to improve energy saving, resource depletion and environment pollution but also will lead to better coping strategies to reduce infection and the spread of covid 19. As a step to achieve applicable infection control guidelines and strategies for management of urban mobility while developing new settlements. The research aims to assess the impacts of neighborhoods factors on people coping urban mobility that could encourage social distance and urban sustainability. The research aims to compare the change in urban mobility behavior before and after the pandemic across different models of neighborhoods in response to covid 19. This research tends to answer the following questions:

- How people coping to covid 19 in different types of neighborhood impact urban mobility?
- How covid19 change urban mobility behavior before and after the pandemic across different types of neighborhoods? How urban form impact travel behavior before and after the pandemic?
- Deduce the main coping strategies of urban mobility to mitigate infection in urban spaces.
- How adopted coping strategies vary across different types of neighborhoods?
- How urban form become more resilient to facilitate coping urban behavior?

1.4. Research Methodology

The research depends on deductive method with comparative analysis of four different types of neighborhoods to trace any significant difference in urban mobility behavior across the four types and deduce the correlation between neighborhood patterns and coping urban mobility behavior before and after the pandemic.

2. COVID19: A NEW PARADIGM OF URBAN MOBILITY (safety vs sustainability)

Urban mobility seems to change with extraordinary and hard events. Lately, covid 19 seems to dramatically impact urban mobility and add challenges to daily travel behavior. Covid 19 is an airborne disease, usually transmitted via inhalation, accordingly safe urban mobility requires infection control strategies to face viral spread in two ways, the first depends on reducing air-born infection from an infected person to another through increasing social distance between people, and the second by minimizing touch and physical contact of droplets through adopted no-touch rules between people and places (Jayaweera et al. 2020).

WHO regulates to avoid crowdedness and keep safe social distance in urban mobility by taking some precautions including displace mobility from shared mobility to single mobility, reduce unnecessary trips, minimize the frequency of some trips, limit the duration of some trips to shorter time periods with others, limit purpose of some trips by closing i.e. mosques, churches, café, restaurants, cinemas, shopping buildings, and public spaces, and moving some activities to augmented schools, work, and universities (WHO, 2020). Physical distance become the main slogan of urban mobility. People fear of infection expected to support different coping mobility strategies to protect themself from infection, to increase social distance and decrease exposure for infection and have safe travel. Accordingly, people are changing their travel modes, many daily trips are reduced, others are changed in term of frequency, duration, and time.

A new paradigm shift in urban mobility is expected, that put social distance as a new way of life to prevent the spread of the virus. A paradigm shifts from the first paradigm of sustainable urban mobility that found efficiency in mass transportation and minimizing the need for extended motorized mobility inside cities, to the new paradigm of safe urban mobility that strive for reducing the face-to-face contact by encouraging single ride mobility to change people behavior to travel safely. Public mobility has become unrecommended, even though it can achieve high sustainability issues, rather it failed to achieve social distance and safety. On the other side, single passive mobility like private car in one hand can provide safety from infection but at the other side could reduce sustainability. A recent growing concern to single active mobility modes like cycling and walkability that can provide safe social distance and at the same time achieve sustainability (Zafri, et.al. 2021).

Neighborhood design must be part of the response to face the spread of the virus, to respect physical and social distance in streets and urban spaces. The correlation of urban form and covid infection are introduced in numerous studies. Different scholars argued that urban form can mitigate and adopt to covid infection (Lak, A., Asl, et.al. 2020; Brizuela, N. G., et.al. 2021). Covid19 raised a challenge of variation in coping behaviors in response to covid19 across different types of neighborhoods. Residential density, building density, land use pattern, and

street network are factors of spatial configuration of urban form that differentiate modern and traditional neighborhoods.

Last decades, traditional urban form was highly perceived as essential factor for sustainability by which city can cope with climate change and encourage social interaction. It places the day-to-day things we need to do in immediate proximity to each other and reduce required transportation and rely on short trip distances which normally happen using walkability and cycling modes. It increases permeability and accessibility and mostly promotes short and direct routes that offer shorter trips and reduce travel distance, it provides different alternative passes and can be more transit friendly to the extent that they may allow greater penetration of an area by transit services. It is expected to enhance walkability and increase trips frequency by foot and reduce trip frequency by private cars, especially with lower parking areas (Ghonimi I., 2017).

Lately, in post-lockdown stage, traditional dense community, high building density, mixed use, and grid street network pattern is mostly perceived as an essential causal relation of insufficient social distance and increasing crowdedness, could have direct causal relationship with the spatial properties of crowding. Accordingly, conceived as basic factors for increasing risk of viral infection and affecting the spread of an epidemic, as it increases contact between people. Scholars consider the greater the population density, mixed use, connectivity, the greater the risk of infection. They sought that reducing density, move to separate-use communities, and increase the travel between places will lead to sufficient social distance in travel behavior and will outbreak the growth of disease transmission (Lak, A., et.al. 2020; Jabareen, Y. et. al., 2021). They thought that the larger the distance, the lower the connection between city parts, the lower the scale of the population flow, the harder the spread of an epidemic across regions.

A misleading perception of promoting some urban forms for misguided reasons to support safe mobility over sustainable mobility could reduce concern to sustainability. This argument needs to be reconsidered, furthermore, it is still unclear to what extent population density, mixed use, and street permeability affects urban mobility in term of infection rate and sustainability.

3. COVID19 AND COPING MOVEMENT URBAN BEHAVIOR:

Urban form has an important role in shaping people daily movement behavior, inturn it can encourage or discourage sustainable urban mobility (Ghonimi, I. 2017). Covid 19 is a hard situation that can challenge the role of urban form in changing daily life urban mobility. The fear of infection, the need for limitation of daily life activities, and need for social distance are the usual challenges of covid19 that make traveling unsafe. In order to face such challenges People adopted coping urban movement behavior that expected to support actions to reduce their viral exposure, maintain more social distance and less crowdedness as key factor for safe mobility.

3.1. Social Distance vs Overcrowding.

Social distance means keeping safe distance between people to limit the spread of viral diseases like COVID-19 (Goniewicz, et al. 2021). Most medical organizations recommend staying at least 1 to 2 m away from others to be safe from infection, and to achieve containment of the

spread of covid-19 (WoW, 2020). In contrast, crowdedness refers to the number of users exceeding the available allowed occupants (Blake, et al. 2007), where safe physical distance is not achieved, that could increase intensity and duration of risk for contagion and viral spread. For the purposes of prevention of airborne disease transmission, HUD defines overcrowding as less than 15.3 square meters of living area per person (Seidlein, et al. 2020). Urban crowding is a matter of people urban behavior that obeys people's intentions, attitude, willing, and interest to exist in urban spaces. An examination of the role of urban form to facilitate coping behavior to encourage social distance and discourage overcrowding can control the chances of viral spread. Assessing how Covid cause urban mobility change helps to predict how to avoid crudeness, achieve safe social distance and meet sustainability requirements.

3.2. Coping Urban Mobility Behavior and Commuting Strategies:

Coping is defined as a change in behavior during or after a difficult situation to maintain physical and mental safety. It is a set of actions taken to deal with stressful or threatening situations (Srivastava, et al. 2014). In confront with covid 19, different coping behavior strategies are adopted to reduce crowdedness in urban spaces and keep social distance. It aims to reduce exposure risk depending on the allowed coping behavior being performed in urban spaces.

Coping aims to reduce lockdown social and economic effects to lower levels, by maintaining safe daily life activities to happen and make life come back to normal state as possible in a safer way. It aims to maintain the social, economic and functional roles of urban spaces in people daily life activities. Coping considers keeping a safe social distance as a challenge of crowd management scientific topic to face covid infection and disease spread. Different coping strategies are recorded in literatures as a matter of redistribution of occupation in terms of time, location, and function to keep density and distribution of occupants in a safe social distance in urban spaces.

Commute means a regular travel to the same place in a repeated way as a part of daily life routine. i.e. to commute to work 5 days per week, go to school 4 days per week. Coping of commuting behavior concerns the change in regular, typical and repeated way of travel to the same place for the same purpose as part of the daily life routine, it concerns change in people's intentions, attitude, willing, and interest to go to the same place in a repeated way as part of daily life routine, what they are more likely and more willing to use, what time they choose, what frequency they use, and distance traveled. People are required to choose travel modes that maintain safe social distance to minimize the chance of infection while traveling safely from one place to another, a revealed transmission risk of each mode. Accordingly, urban mobility witnessed a paradigm shift from the first paradigm that found efficiency in accessibility with mass transportation, minimizing the need for extended movement, reducing the need for motorized demand, reducing the number of motorized trips, reducing travel distances inside cities, and changing the modal split, to the new paradigm that strive for reducing the face-to-face contact based on coping strategies of reducing unnecessary transportation, displace mobility from public to single modes i.e. walkability, cyclability and private transportation.

The Centers for Disease Control and Prevention (CDC, 2020), World Health Organization (WHO, 2020), United Nations Human Settlements Program (UN, 2020), and National

association of city transportation officials (NATCO 2020) have issued guidelines for the control, prevention, and evaluation of COVID-19 that are summarized in the following points:

- Reduce mobility density: It refers to a number of commutes per certain time within a safe social distance. It probes the limit people are willing to reduce commute needs. It aims to reduce unnecessary trips, minimize necessary trips, shift from physical to virtual modes, and increase travel routes capacity to reduce commute density.
- The variable "mobility mode choices" refer to people willing to use certain travel modes than others included during day hours, during night hours, till late night. It probes the degree to which residents feel safe in using certain mobility modes than others with certain duration at certain times of the day. By using equal alternative different safe modes, increasing the alternatives to give great variety, moving mobility from public modes to single modes including private car and walkability. Change mode choice of mobility to safer modes refers to the way people are willing to behave.
- Reduce total trip distance: "Trip Distance" refers to the types of travels based on the trip distance, residents long trip distance, medium trip distance, and short trip distance. It props the degree residents found it safe and easy to do trips. According to the distance they are willing to make using certain modes at certain times of the day.
- Reduce the trip frequency: "Trip Frequency" refers to the time residents can repeat their trips per week; (low-frequent trips for 1 time per day – medium-frequent trips for 3 to 5 times per day and high frequent trips for 6 to 8 times per day). It probes the degree to which resident found it easy and safe to repeat their trips, by certain modes at certain times of day.
- Reduce the mobility duration: It refers to the time residents are spending in each mobility type. It can be classified as Short-stay, Medium-stay, and Long-stay mobility. It probes the degree to which residents are forced to spend more time to do certain behavior by certain modes at certain times of the day. Increasing the duration of contact with infected persons will increase the risk of infection.
- Distribute mobility to different times: It refers to the ability of occupation at different times of the day and the week. It can be classified as early-morning, mid-day, late-night occupation. It probes the degree residents can occupy urban spaces at different times of the day morning, afternoon, and evening.
- Distribute occupation to different locations: It refers to the ability of occupation at different locations of the community. It can be indoor or outdoor, central or linear. It probes the degree residents occupy urban spaces at different places to do different activities.

Coping of Commuting strategies depends on reducing total trip frequency, reducing long duration trips, distribute commuting to different times of the day, displace activities from physical to virtual, change the way of doing some commute trips. Covid-19 is expected to cause urban mobility behavioral changes in different types of neighborhoods, it could have a great encouragement or barrier to achieving social distance in comparison to social sustainability. Covid 19 is expected to make deep change in the patterns of urban daily-life mobility. It can impose new mode choices, can diminish some mode choices, and can minimize the frequency of some trips and distance of other trips and can change the way people used to perform some mobility patterns. Coping urban mobility favored single-occupancy ride over public transportation, they can limit contact and achieve social distance for short and long-distance

mobility. Furthermore, reducing total mobility, reduce public transportation, increase private mobility, shift mobility to different times of the day, and shift mobility to single-occupancy ride. Accordingly, it could have a great encouragement or barrier to achieve a safe social distance and meet sustainability.

Coping of commute strategies requires different investigation tools to give clear conclusion for measuring social behavioral change. It depends on spatial measure, questionnaire and ethnographic observation of coping behavior including mode choices, frequency, duration, and way of doing that activity. Quantification of urban mobility is essential for assessing its role in covid infection, and control pandemic (Hackl, J., et.al. 2019). Measuring patterns of urban mobility can be defined using different parameters including travel mode-choices, trip frequency, trip distances, and overall trip distances.

- The variable "purpose of mobility" refers to the different types of reasons for doing physical activities including trips for necessary activities e.g. work, education, shopping; trips for optional activities e.g. sport, entertainment, and recreation; and trips for social activities e.g. meeting friends, family, and neighbors.
- The variable "Modes of urban mobility" refer to the way urban activities can happen including passive motorized mobility and active motorized mobility. In addition, it refers to single mobility ride, and public mobility ride.
- The variable "Frequency of urban mobility" refers to the times that certain trips could happen per day, it includes high, medium, and low-frequent trips.
- The variable "Distance trips of urban mobility" refer to the types of trips in term of distance that can happen including short-distance, medium distance, and long-distance trips.
- The variable "Duration of urban mobility" refers to the time residents are spending in each activity per day including short-stay, medium-stay, and long-stay trips. It measures residents' sense of safety to spend more time in such mobility mode at certain times of day.
- The variable "Time of urban mobility" refers to the time residents are willing to do their mobility including morning, afternoon, and evening trips. It measures residents are feeling safe for commuting at certain times of day.

TABLE 1: SUMMARIZED VARIABLES FOR MEASURING COPING BEHAVIORAL URBAN PATTERNS.

Urban mobility coping behavior		Recommendation to enhance coping behavior
Reduce mobility (purpose)	Depend on virtual modes Limit to necessary trips, and reduce unnecessary trips.	Reduce unnecessary trips
Mode choice of urban mobility	Mode of urban mobility according to purpose and distance of mobility (Pedestrian, cycling, private, public) Single-occupancy and Public-occupancy ride Active mobility, and passive mobility	Depend on single occupancy ride. Distribute mobility to an equitable save alternative.
Frequency of urban mobility	Frequency of trips	Reduce frequency of mobility.

	(High frequency, medium frequency, single frequency) trips.	Limit to single frequency trips.
Duration of urban mobility	Duration of trips according to destination (Short-distance, medium-distance, and long-distance trip).	Reduce long distance trips Limit to short-distance trips that are 15min walkability.
Total trip distance urban mobility	Distance of mobility according to purpose (Long distance, medium distance, short distance).	Reduce total trip distance. Encourage short and medium trips over long ones.
Time of trips	Time of doing physical (personal) activities. (Morning, After non, Night) trips.	Distribute mobility to different times of the day.

4. THE CASE STUDY OF FOUR CATEGORIES OF NEIGHBORHOODS

The aim is to trace any significant differences in patterns of urban mobility in responses to Covid 19 across different categories of neighborhoods. The relationship between neighborhood design and urban mobility change in response to covid 19 will be examined to develop design guidelines to minimize the spread of covid 19.

4.1. Case Study Selection

Four types of neighborhoods are selected to present different design pattern in Greater Cairo Region, the central early developed, the early planned, the flourish of new settlements to the west and the east, and the private gated communities. Abasia is selected to represent early developed neighborhoods, Nasr city is selected to present early planned neighborhoods, Jasmine in New Cairo is selected to present new planned neighborhoods, and G22 in Madinaty is selected to present the contemporary planned neighborhood as in Figure 1.

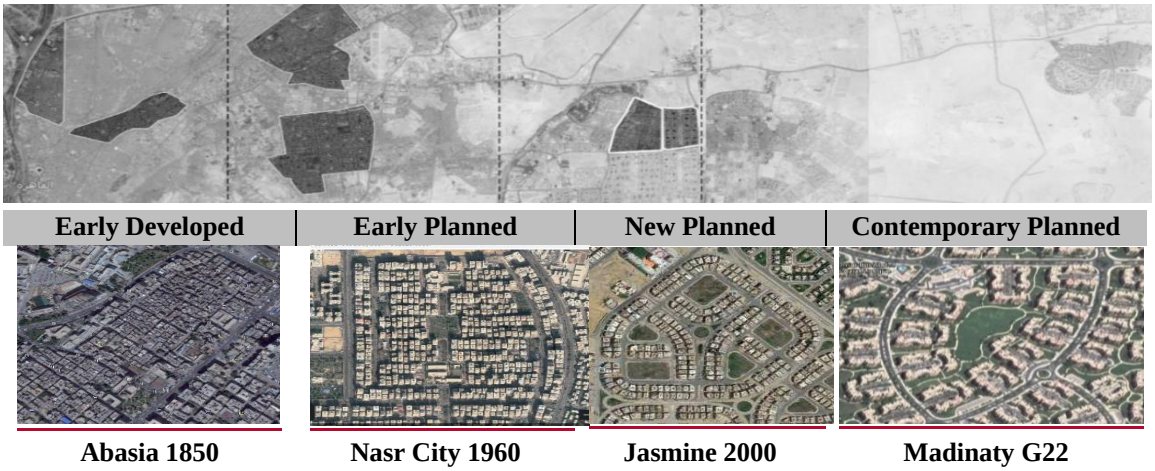

Figure (1): Selected case study areas across different stages of GCR – Egypt.

4.2. Data collection and classification:

Two forms of data were collected, the first measures patterns of urban form based on spatial data, the second measures patterns of coping urban mobility based on questioner and observation, finally their correlation are deduced.

4.2.1. Measurements of urban patterns:

This part proposes to measure urban form patterns represented in street network pattern, housing income pattern, and land use pattern. Data was collected using surveying maps, observations, satellite maps, photographic images to document and explore neighborhoods urban configuration patterns including land-use pattern, housing income pattern, street network pattern as follow:

- Street-network patterns are classified under the headings (grid, loop, and tree patterns), (Linear feet of streets, No. of blocks, No. of intersections, No. of access point, No. of cul-de-sacs, and percentage of streets area) and (Depth, cycle, permeability, and accessibility index).
- Land use patterns are classified under three headings Land-use diversity, Land use variation, and Land use density.
- Housing patterns are classified under four headings Housing variation, Housing mix, (inclusion vs. segregation), and Housing Density ranges between low density (60-120 Person/ Acre), soft density (300-500 Person/ Acre) and hard density (800-1000 Person/Acre).
- Community size ranged among small, medium, and large community size.

4.2.2. Measuring patterns of urban mobility:

Measuring patterns of urban mobility concerns residents change in typical and repeated ways of travel and what they are more likely to do to keep social distancing, it requires different investigation tools, to give clear conclusion. Coping urban behavior data were collected through observation and an online questionnaire survey. A questionnaire administered to district residents: Samples selection of average 40 residents are randomly selected in each case study area that represents different gender, age, education, and income. It depends on closed ended questions using 5 Likert scale. The questionnaire listed major expectation of people coping urban behavior attitudes to keep social distance including questions on trip purpose (necessary, optional, social), mode choices (public transportation, private cars, cycling, walkability), travel distance (long distance trips, medium distance trips, short distance trips) and travel frequency (high frequent trips, medium frequent trips, and low frequent trips), and travel time of trips(morning, after noon, evening) before and during COVID-19. Table (2) represents recorded coping indicators.

TABLE 2

RECORDED SCORES FOR COPING BEHAVIOR OF URBAN MOBILITY PATTERNS BEFORE AND AFTER COVID19

Coping Mobility	Urban	Assesment Factors	Early Development		Early Planned		New Planned		Private ommunity	
			Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Travel Purpose	Necessary purpose	Work	4.50	2.50	4.50	3.00	4.5	3.00	4.50	4.00
		Educate	4.50	4.00	4.500	4.00	4.50	2.00	4.500	4.00
		Shop	4.50	3.00	4.00	3.00	3.50	1.00	4.50	1.50

	Optional purpose	Encourage kids playing	3.50	2.00	2.00	1.00	1.50	0.50	3.00	3.00
		Entertainment and Recreation	4.50	2.50	3.50	3.00	1.50	0.50	3.00	4.00
		Walking, Dogging and Cycling	0.50	0.50	2.00	1.00	3.00	1.50	3.50	1.50
	Social purpose	Social occasions	4.50	2.50	3.00	3.00	1.50	0.50	2.50	2.00
		Religion occasions	4.50	2.50	3.50	3.00	1.50	0.50	3.00	2.00
		Meet Neighbors and Friends	4.00	2.50	2.50	3.00	2.00	0.50	3.50	2.00
Travel mode choices	Long distance trips	Private transportation	1.00	1.50	1.50	1.75	2.50	2.00	2.00	2.00
		Public transportation	2.50	0.25	1.75	0.25	0.50	0.25	1.00	0.25
		Walkability	1.00	1.50	0.75	0.75	0.25	0.25	0.50	0.50
		Cyclability	0.50	0.75	0.50	0.75	0.25	0.25	0.50	0.75
	Coping using sustainable and safe modes		5.00	4.00	4.50	3.50	3.50	2.75	4.00	3.50
	Medium distance trips	Private transportation	0.50	1.00	1.00	3.00	2.25	1.50	1.50	1.00
		Public transportation	2.00	0.25	1.50	0.25	0.50	0.25	1.00	0.25
		Walkability	2.00	2.00	1.50	2.00	0.50	0.75	1.00	2.00
		Cyclability	0.50	0.75	0.50	0.75	0.25	0.50	0.50	0.75
	Coping using sustainable and safe modes		5.00	4.00	4.50	3.50	3.50	3.00	4.00	2.50
	Short distance trips	Private transportation	0.25	1.00	0.50	1.00	2.00	1.50	1.50	1.50
		Public transportation	1.25	0.25	1.00	0.25	0.50	0.25	1.00	0.25
		Walkability	3.00	2.00	2.50	1.50	0.75	0.50	1.00	1.50
		Cyclability	0.50	0.75	0.50	0.75	0.25	0.25	0.50	0.25
	Coping using sustainable and safe modes		5.00	4.00	4.50	3.50	3.50	2.50	4.00	3.50
Trip distance	Long distance trips		1.00	0.75	2.50	1.50	3.50	3.00	3.50	3.00
	Medium distance trips		1.50	2.00	1.50	1.50	1.00	1.25	1.00	1.25
	Short distance trips		2.50	2.25	1.00	2.00	0.50	0.75	0.50	0.75
	Coping by reducing long-distance trips		5.00	4.00	4.50	3.50	3.50	3.00	4.00	2.50
Trip frequency	High Frequent Trips		2.50	2.00	1.00	1.00	0.50	0.50	0.50	0.50
	Medium Frequent Trips		1.50	1.00	1.50	1.00	1.00	0.50	1.00	1.00
	Low Frequent Tirps		1.00	0.50	2.50	1.50	3.50	1.50	3.50	2.00
	Coping by reducing high frequent trips		5.00	3.50	4.50	3.50	3.50	2.50	4.00	3.50

5. RESULTS AND DISCUSSION

Based on the collected data, this part aims to trace any significant differences of patterns of urban mobility across different types of neighborhoods in terms of trip purpose, trip frequency, trip distance, and mode choices. Empirical data in table (2) revealed a significant coping behavioral change in urban mobility across different types of neighborhoods. It revealed that all neighborhoods reported a significant decrease in total concern for mobility and a total decrease in daily trip distance in term of daily trip frequency, and daily trip distance. People lose interest to include to urban spaces.

5.1. Coping by reducing unnecessary trips (Purpose of travel):

Figure (2) reveals that total mobility in term of total purpose is reduced with moving from traditional to modern neighborhoods. It also revealed a change in the primary purpose of travels:

- Trips for necessary purposes records 58%, 40%, 38% respectively. It is reduced after pandemic to 38%, 16%, and 10% respectively.
- Trips for optional purposes records 58%, 40%, 38% respectively. It is reduced after pandemic to 38%, 16%, and 5% respectively. A deduced high reduction with moving from modern to traditional.
- Trips for social purposes records reduced in modern and early planned neighborhoods.

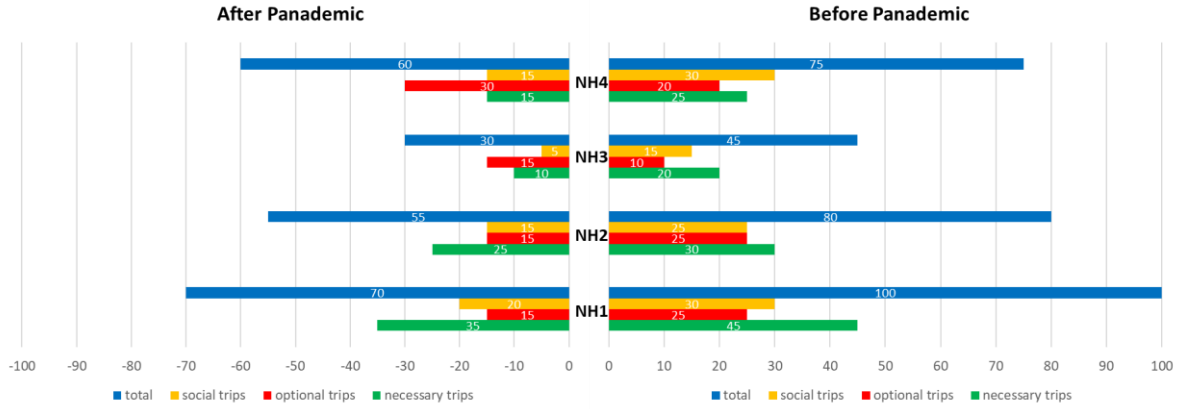

Fig. 2. Graphical representation of modes of urban mobility.

Figure (2) revealed that the primary purpose of mobility before and after covid showed significant change in different types of neighborhoods:

- In traditional and early planned neighborhoods, it showed total reduction in all types of mobility, but still the primary travel purpose is necessary activities of work, education and shopping, before and after the pandemic.
- In modern and contemporary neighborhoods, it showed a relative reduction in all types of mobility purposes from percentages of 20%, 10%, 15%, to 10%, 15%, and 5% respectively. In addition to a shift of the primary travel purposes from necessary purpose before the pandemic with percentage 20% to the optional purpose of dogging and walkability with percentage of 15%.
- In contemporary neighborhoods, the primary travel purpose changed from the necessary work, education, and shopping before pandemic of 25% to the optional entertainment, dogging and walking after pandemic of 35% after pandemic.

It seems that modern and contemporary neighborhoods failed to keep safe trips for necessary mobility and shift concern to do trips for optional and social purposes than traditional neighborhoods. This can be explained that as larger wide streets and urban spaces can encourage trips for optional purposes, rather the long distance for work, education and shopping did not provide people to travel safely accordingly they encouraged virtual alternatives over physical one.

5.2. Coping by reducing un-sustainable trips (Trip distance):

Figure (3) revealed a total reduction in total trip distance in all types of neighborhoods, it revealed high reduction with moving from traditional to modern neighborhoods.

- In traditional neighborhoods, it indicates people concern of short and medium distance trips before and after the pandemic, that reflected relative low reduction in total trip distances.
- Early planned neighborhoods minimize people concern about long-distance trips for necessary activities only; and it encourages medium and short-distance trips which facilitate walkability as a safe single and sustainable means of mobility.
- In modern neighborhoods, it indicates a concern towards long distance trips before the pandemic, it showed high decrease of concern after the pandemic, which is reflected to increased reduction in total trip distance. It also indicates increased rely on private cars as safe single mobility but also as an unsustainable mobility for each trip.

Figure (3) reveals that all NHS records show a significant reduction in total distance. Moving from traditional to modern neighborhoods revealed decrease in long, medium, and short-distance trips with different values as follow:

- Long-distance trips are being encouraged with moving from traditional to modern neighborhoods, it records 10%, 40%, 60% and 70%.
- Medium-distance trips are increased in traditional and early planned neighborhoods and removed with moving to modern neighborhoods.
- Short-distance trips are reduced with moving to modern neighborhoods. This can be explained as the traditional provides necessary activities within 15 min walking distance.

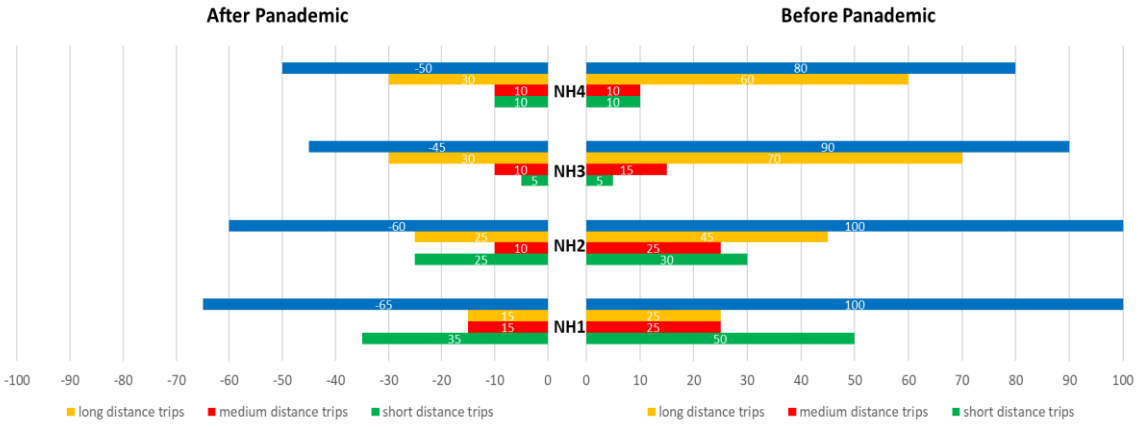

Fig. 3. Graphical Representation of Trip distance across different types of neighborhoods.

Covid reduced the concern for long distance trips in all types of neighborhoods. Traditional and early planned neighborhoods can cope by depending on short and medium distance trips in doing necessary activities, unlike modern neighborhoods that force their residents for

depending on long distance trips using private cars otherwise their residents will have to reduce their necessary needs.

In addition, People in an aim to avoid the need to move long distance trips for work, education, shopping and do other necessary activities from home. On the second hand, they become un-willing to travel medium and short distance trips for shopping or walking. It seems that reduced travel for active necessary activities discourage travel for passive medium and short trips for shopping. It seems that modern neighborhoods failed to provide coping by reducing long distance unsafe and unsustainable trips.

5.3. Coping by reducing trip frequency of urban mobility (trip frequency):

Figure (4) reveals a total reduction in frequent trips, in addition it is concluded that coping with reducing trip frequency revealed a significant difference across different types of neighborhoods:

- Traditional neighborhoods showed a significant concern for high frequent trips, it seems that their dependence on short and medium distance trips increase the residents' tendencies towards high frequent safe inclusion to urban spaces.
- Early planned neighborhoods facilitate high frequent trips over limited low frequent trips, they encourage a safe inclusion.
- Modern neighborhoods revealed reduction of high-frequent trips and limitation of low-frequent trips, it discourages safe inclusion, it seems that its rely on long distance trips causes residents not to be willing to repeat the trips, also it seems that their residents are not willing to travel medium and short distance trips for shopping or walking that limited the travel to be for only necessary activities, and discourage travel for passive medium and short trips for shopping.

Total trip frequency revealed a total reduction in all neighborhood types.

- High frequent trips are highly associated to low distance trips, where short trip distance is easier for people to repeat without suffering from effort, cost and time and without fair of infection.
- Low and medium frequent trips are associated to long frequent trips, where residents found it consuming effort, time, and cost and unsafe to repeat trips.

High-frequent trips for necessary activities like work, education, and shopping are reduced, where the virtual interaction alternatives give better coping behavior through E-learning, E-working, and E-shopping. Empirical evidence revealed a modal shift in urban mobility, where total concern for mobility is reduced in all types of neighborhoods, the reduction is gradually increased with moving from traditional to modern neighborhoods 10%, 20%, 30%, and 40% respectively. This can be explained as follow:

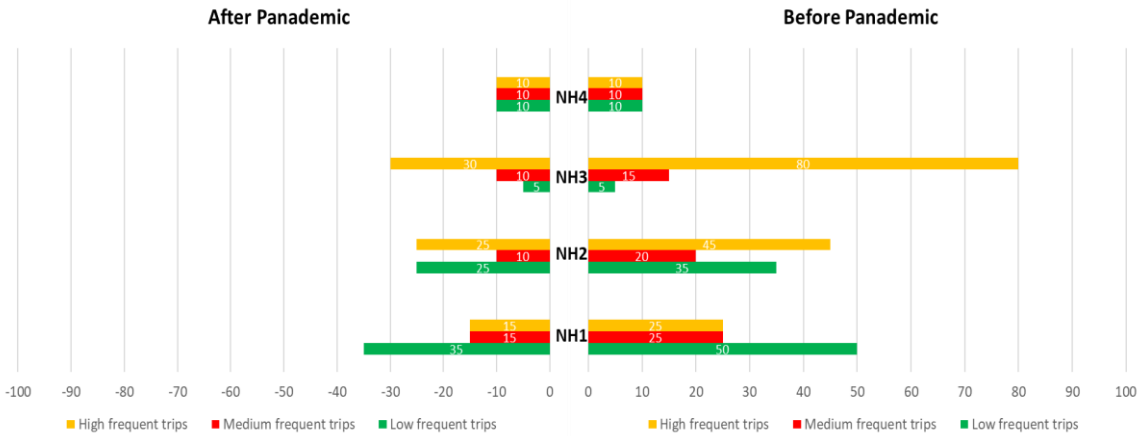

Fig. 4. Graphical representation of trip frequency across different types of neighborhoods.

Traditional neighbourhoods showed high trip frequency per day for necessary activities, unlike, modern neighbourhoods. It seems that traditional neighborhoods facilitate coping movement behavior at different times of the day, different safe modes, to do their daily life trips. On the contrary, modern neighborhoods did not allow equitable safe coping mobility behavior that make people forced to take-off their unnecessary trips and reduce great part of their necessary trips.

5.4. Coping alternative safe equitable personal mode choices

Figure (5) reveals a significant difference of coping of modal choice across different types of neighborhoods before and after pandemic. Walkability is reduced with moving from traditional to modern neighborhoods they record 60%, 50%, 20%, and 10% respectively. Private mobility is increased with moving from traditional to modern, it records 10%, 25%, 50%, and 70% respectively. Public transportation records reduced values in all types of neighborhoods ranges between 5% to 15%, this can be explained as follow:

- Traditional neighborhoods facilitate coping of equitable mobility by turning from public modes to walkability as equitable single mobility for short distance trips.
- Early planned neighborhoods facilitate coping of equitable mobility by turning from public modes to walkability as equitable single mobility for short and medium-distance trips and necessitate private mobility for long-distance trips.
- Modern neighborhoods necessitate coping of unequitable mobility from public to private modes for short, and medium-distance trips, otherwise reduction of total mobility.
- Contemporary NHs encourage coping of mobility using walkability for short-distance trips and necessitate private mobility for medium-distance trips.

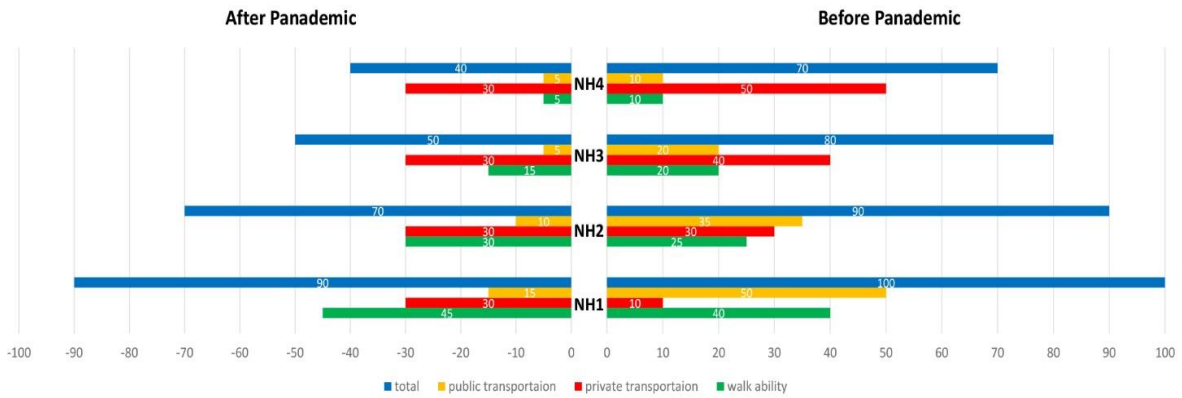

Fig. 5. Graphical representation of Travel Mode Choices across different types of neighborhoods.

Figure (5) reveals that all NHs favored walkability and private mobility as single-occupancy ride over public transportation, they are safe mobility that can limit contact and achieve social distance for short and long-distance mobility in order to avoid face to face contact with others. Crowded public transit are not safe and are not desirable, so people choose to depend on private mobility or walkability to achieve social distancing. Where Public mobility loses its attraction in front of private and walkability modes. On the other side, traditional community records rely on walkability and cyclability for short-distance trips to achieve safety. In contemporary NHs, walkability is not practical and private car provide single safe mobility solution.

It seems that modern compared to traditional neighborhoods failed to provide coping to alternative equitable single modes of mobility, walkability is not a practical solution because of the long-distance trips. Accordingly, they are forced to use private mobility otherwise they must stay at home and take-off the necessary and unnecessary (optional and social) activities.

6. RECOMMENDATIONS AND DESIGN GUIDELINES

This part intends to deduce the impacts of neighborhoods urban configuration on coping urban mobility behavior to achieve social distance and reduce crowdedness rates.

6.1. Deducing the conflict of sustainable mobility and safe mobility

Figure (6) represents the recorded values of sustainable mobility before and after the pandemic. The up bar in traditional and early planned neighborhoods reveals green difference to more sustainable mobility, it can achieve coping commute behavior in addition to achieving increased sustainability difference as before the pandemic, on the contrary the up bar of modern and contemporary neighborhoods revealed in red values reduced sustainability in its way to achieve safe mobility, it supports unsustainable mobility behavior.

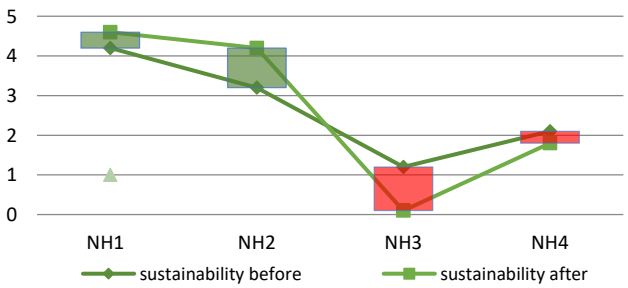

Fig. 6. A comparison of sustainable mobility before and after the pandemic.

It seems that complete local communities at local level enhance walkability and cyclability as main mobility mode for work, education, shopping, and any other aspect of life. It can help to enhance sustainability, at the same time achieve safety against viral infection. It is concluded that substitution of low density with soft density as in early planned neighborhoods can create complete 15min travel community that facilitate coping by facilitating equitable and sustainable single ride mobility and could mitigate viral infection.

6.2. Deducing the impacts of neighborhoods urban configuration on safe and sustainable mobility

6.2.1. The impacts of Density on the spread of covid infection:

Figure (7) reveals that reducing density is not corresponding to equitable safe mobility behavior, rather it revealed that soft density like early planned neighborhoods can keep a safe social distance and safe occupation rates than traditional and modern neighborhoods by encouraging walkability as equitable single occupancy ride, distribution of mobility at different times of the day. It seems that high density community facilitate walkability and cycling as equitable safe travel mode for short and medium trips than public transportation. On the contrary, low density would increase demand for motor private mobility that would be safe for high income communities who can afford their cost, rather it is inequitable for low-income people who are forced to use public transportation.

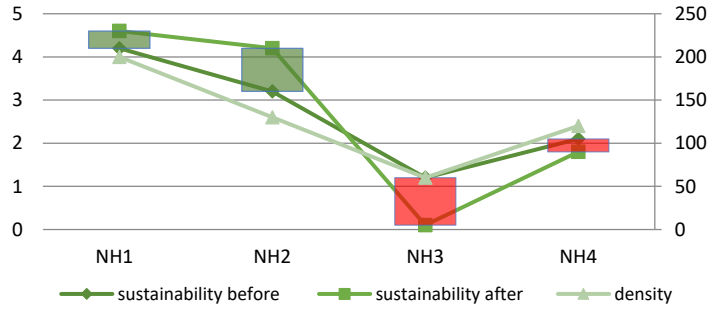

Fig. 7. Relation between density and social distance.

Reduced density makes walkability not practical and unsafe and makes private car inequitable mobility for low income, single car family, elders, and adults. Otherwise, all residents need to have private car to travel safely, which is more expensive for who can afford private car and can pay its running cost and reduce sustainability of contemporary city due to increased fuel consumption and air prolusion, and exclusive for low income who cannot afford private car or cannot afford its cost. On the other side, dense short-distance communities make walkability favorable as safe mobility.

6.2.2. The impacts of mixed use on the spread of covid infection:

Figure (8) revealed that reducing mixed use is not corresponding to equitable safe mobility, rather distributed services to linear multicenter can enhance social distance in different ways: first it reduces travel distance and encourage walkability as feasible and safe solution. Second, it facilitates distribution of people than concentration to central service area. Third, it makes taking social distance precautions easier, being controlled, and safe than centralized solution that makes taking social distancing hard to control.

It seems that mixed use community facilitates distribution of activities and crowdedness at different times of the day, and different places of the community. Separate use causes centralization of services to certain location where all community people are forced to include to get their services. This will reduce people opportunities for coping behavior, cause more crowdedness and reduce social distancing. It is concluded that substitution of neighborhood service center with soft mixed use as in early planned neighborhoods that can facilitate coping by distribution of activities to different places of the community and can facilitate mobility depending on walkability as single mobility mode and could mitigate viral infection.

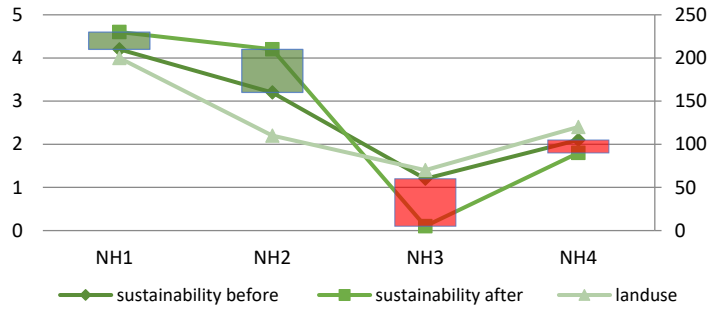

Fig. 8. Relation between land-use patterns and safe and sustainable urban mobility.

Separate use causes centralization of services to certain location where all community people are forced to include to get their services. This will reduce people opportunities for coping behavior, causing more crowdedness and reducing social distance.

6.2.3. The impacts of street patterns on covid infection:

Figure (9) revealed that moving to treed street patterns is not corresponding to equitable safe mobility. This can be explained as it seems that grid patterns provide alternative short distance paths, that encourage walkability as equitable single-occupancy ride over public transportation. It encourages short and medium-distance trips. Walkable streets are more encouraging for social distancing than unwalkable streets, the first increases safe urban mobility, the second limits mobility to private mobility for long and short distance trips which could be unequitable for low-income people, and also unsustainable.

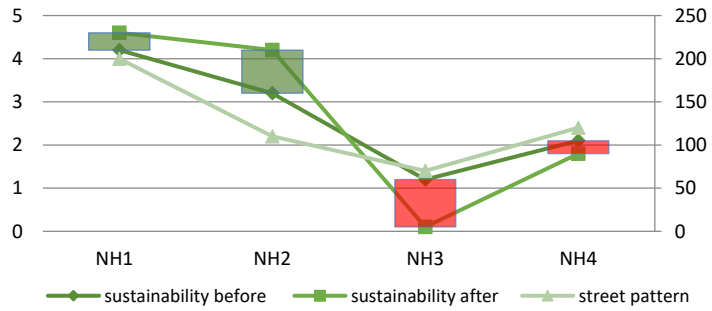

Fig. 9. Relation between street network patterns and social distance.

Public transportation has become unsafe, so walkability and cyclability have become the best options for short-distance trips. High walkability communities have less infection rates with covid 19. Different types of street network could encourage walkability and accordingly provide

safe mobility options. People in high density community take a behavior of social distancing seriously. They limit their movement to necessary activities depending on equitable single ride mobility modes. People in low density community become more socially connected, they are more willing to include to urban spaces than before the pandemic and they showed lower precautions regarding social distancing.

7. CONCLUSION

Covid 19 is one of the recent emerged respiratory viruses that caused a dramatic impact on contemporary and future city. Covid 19 is proved to have great impacts on people movement behavior. People adopt different coping strategies to put social distancing as a key factor in their life style, and caused behavioral changes as well. Empirical evidence records significant coping differences across different types of neighborhoods.

1) Traditional neighborhoods are not necessarily corresponding to high crowdedness and less social distance. Rather a great role of urban form in shaping people coping behavior that can encourage redistribution of occupation to different times of the day, different places of the community, and create concern about equitable single drive mobility.
2) Early planned neighborhoods revealed lowest occupation density, and lowest crowdedness. It revealed high people coping behavior that can encourage redistribution of occupation to different times of the day, different places of the community, and create concern about equitable single mobility drive.
3) Modern neighborhoods revealed highest occupation density, and crowdedness. It discourages redistribution of occupation to different times of the day, different places of the community, and creates concern about inequitable single drive mobility.

To face covid infection and enhance sustainability; planners are required to follow the following recommendations and strategies to maintain safe social distancing in urban mobility:

1) Change city criteria to encourage dependence on short distance trips by imposing small communities that provide all types of services within walking distance. In order to increase interest of people to depend on walkability for most of the travel needs. This could reduce traffic flow, traffic cognition, parking requirements.
2) Encourage small community with mobility within walking distance. And encourage safe cyclability and pedestrian walks. have safe space for social/physical distancing while getting outside.
3) New standards with wider sidewalks and increased streets width to increase safe space for walking and cycling and reduce car use during and after the pandemic, to meet required capacity with achieved social distancing while walking and cycling.
4) Transforming streets to increase space for walking and cycling and reduce car use during and after the pandemic.
5) Street’s design could be narrower and limited in parking requirements per occupant. Pedestrian and cycle mode choices are increased so their urban requirements for pathways are increased.

8. REFERENCES

1. Allam, Z., & Jones, D. S. (2020). Pandemic stricken cities on lockdown. Where are our planning and design professionals [now, then and into the future]. Land Use Policy, 97, 104805.
2. Bazant, M. Z., & Bush, J. W. (2021). A guideline to limit indoor airborne transmission of COVID-19. Proceedings of the National Academy of Sciences, 118(17).
3. Blake, K. S., Kellerson, R. L., & Simic, A. (2007). Measuring overcrowding in housing.
4. Brizuela, N. G., García-Chan, N., Gutiérrez Pulido, H., & Chowell, G. (2021). Understanding the role of urban design in disease spreading. Proceedings of the Royal Society A, 477(2245), 20200524.
5. Chang, V. (2020). The post-pandemic style. Slate. https://slate. com/business/2020/04/coronavirus-architecture-1918-flu-cholera-modernism. html.
6. Dietz, L., Horve, P. F., Coil, D. A., Fretz, M., Eisen, J. A., & Van Den Wymelenberg, K. (2020). 2019 novel coronavirus (COVID-19) pandemic: built environment considerations to reduce transmission. Msystems, 5(2), e00245-20.
7. Gandy, M., The Paris sewers and the rationalization of urban space. Transactions of the Institute of British Geographers, 1999. 24(1): p. 23-44.
8. Ghonimi, I. (2021). The Role of Urban Space Configuration in Maintaining Social Inclusion: A comparison of Four Types of Neighborhoods in Greater Cairo Region-Egypt. Journal of Urban Research, 39, 75-104. https://dx.doi.org/10.21608/jur.2021.30232.1002.
9. Ghonimi, I., & El Zamly, H. (2017). Sustainable Urban Mobility: Assessing Different Neighborhood Models in Greater Cairo Region, Egypt. In 22nd REAL CORP 12-14 September 2017, Vienna; Austria (pp. 561-575).
10. Goniewicz, K., & Khorram-Manesh, A. (2021). Maintaining Social Distancing during the COVID-19 Outbreak. Social Sciences, 10(1), 14.
11. Habitat, U. N. (2020) UN-Habitat Guidance on COVID-19 and Public Space, United Nations Human Settlements Programme.
12. Habitat, U. N. (2021) Cities and Pandemics: Towards a More Just, Green and Healthy Future. United Nations Human Settlements Programme.
13. Habitat, U. N. (2021). Cities and Pandemics: Towards a More Just, Green and Healthy Future. United Nations Human Settlements Programme.
14. Hackl, J., & Dubernet, T. (2019). Epidemic spreading in urban areas using agent-based transportation models. Future internet, 11(4), 92.
15. Hu H, Nigmatulina K, Eckhoff P. (2013) The scaling of contact rates with population density for the infectious disease models. Mathematical Biosciences. 2013;244(2):125–34. pmid:23665296
16. Jabareen, Y., & Eizenberg, E. (2021). The failure of urban forms under the COVID-19 epidemic: towards a more just urbanism. The Town Planning Review, 92(1), 57-63.
17. Jayaweera, M., Perera, H., Gunawardana, B., & Manatunge, J. (2020). Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy. Environmental research, 188, 109819.
18. Lak, A., Asl, S. S., & Maher, A. (2020). Resilient urban form to pandemics: Lessons from COVID-19. Medical Journal of the Islamic Republic of Iran, 34, 71.
19. Megahed, N. A., & Ghoneim, E. M. (2020). Antivirus-built environment: Lessons learned from Covid-19 pandemic. Sustainable cities and society, 61, 102350.

20. Mei S, Chen B, Zhu Y, Lees MH, Boukhanovsky AV, Sloot PMA. (2015) Simulating city-level airborne infectious diseases. Computers, Environment and Urban Systems. 2015;51:97–105. https://doi.org/10.1016/j.compenvurbsys.2014.12.002.
21. Ong SWX, Tan YK, Chia PY, Lee TH, Ng OT, Wong MSY, Marimuthu K. 2020. Air, surface environmental, and personal protective equipment contamination by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from a symptomatic patient. JAMA https://doi.org/10 .1001/jama.2020.3227.
22. Rader B, Scarpino S, Nande A, Hill A, Reiner R, Pigott D, et al. (2020) Crowding and the epidemic intensity of COVID-19 transmission. medRxiv. 2020:2020.04.15.20064980.
23. Sepe, M. (2021). Covid-19 pandemic and public spaces: improving quality and flexibility for healthier places. URBAN DESIGN International, 26(2), 159-173.
24. Srivastava, S., Singh, J. P., & Srivastava, O. P. (2014). Stress and coping style of urban and rural adolescents. International Journal of technical research and applications, 2(5), 217-220.
25. Sy, K. T. L., White, L. F., & Nichols, B. E. (2021). Population density and basic reproductive number of COVID-19 across United States counties. PloS one, 16(4), e0249271.
26. Van Boven M, Koopmans M, Du Ry van Beest Holle M, Meijer A, Klinkenberg D, Donnelly CA, et al. (2007) Detecting Emerging Transmissibility of Avian Influenza Virus in Human Households. PLOS Computational Biology. 2007;3(7):e145. pmid:17676981
27. Von Seidlein, L., Alabaster, G., Deen, J., & Knudsen, J. (2020). Crowding has consequences: Prevention and management of COVID-19 in informal urban settlements. Building and environment, 107472.
28. World Health Organization (WHO), (June, 2020), "1m, 1.5m, 2m — the different levels of social distancing countries are following amid Covid19," Available: https://theprint.in/theprint-essential/1m-1-5m-2m-thedifferent-levels-of-social-distancing-countries-are-following-amidcovid/449425/
29. Wu T, Perrings C, Kinzig A, Collins JP, Minteer BA, Daszak P. (2016) Economic growth, urbanization, globalization, and the risks of emerging infectious diseases in China: A review. Ambio. 2017;46(1):18–29. Epub 2016/08/06. pmid:27492678; PubMed Central PMCID: PMC5226902.
30. Zafri, N. M., Khan, A., Jamal, S., & Alam, B. M. (2021). Impacts of the COVID-19 Pandemic on Active Travel Mode Choice in Bangladesh: A Study from the Perspective of Sustainability and New Normal Situation. Sustainability, 13(12), 6975.
31. "COVID-Ready Office Design: Retrofitting Buildings with Social Distancing in Mind" 01 Mar 2021. Archdaily. Accessed 9 Aug 2021. <https://www.archdaily.com/957437/covid-ready-office-design-retrofitting-buildings-with-social-distancing-in-mind> ISSN 0719-8884
32. "COVID Occupancy Assessment: How is the COVID Score Calculated?" https://help.covetool.com/en/articles/4295290-covid-occupancy-assessment?utm_medium=website&utm_source=archdaily.com
33. (CDC) Centers for Disease Control and Prevention. Interim guidance on management of coronavirus disease 2019 (COVID-19) in correctional and detention facilities. Available at: https://www.cdc.gov/coronavirus/2019-ncov/community/ correction-detention/guidance-correctional-detention.html. Accessed 29 April 2020. Pena, W. M., & Parshall. S. A. (2012). Problem seeking: An architectural programming primer. John Wiley & Sons.
34. (NACTO) National association of city transportation officials, (2020). streets of pandemic response &recovery, Retrieved August 22, 2020 from https://nacto.org/publication/streetsfor-pandemic-response-recovery/emerging-street-strategies/outdoor-dining/