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Smart City: A Question of Social Sustainability in Urban Spaces?

Assessing The Impacts of ICT on Changing Urban Behavioral Patterns in Urban Spaces of Madinaty, Egypt.

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ABSTRACT

Smart city is one of the powerful concepts that have deep impacts on contemporary cities. Planners, developers, and authorities thought that change to smart city using information and communication technologies could enhance the quality of urban life; rather, still their impact on long-term change of social life and consequently on social sustainability in contemporary cities is not fully investigated. Some scholars argued that moving from conventional to smart city will greatly encourage social activities in urban space. In contrast, this research argues that increasing people familiarity with ICT will create new urban behavioral patterns that could build great barrier to urban social sustainability. It aims to take the proper precautions for any expected negative impacts on social sustainability. The research adopts a case study of three parks in Madinaty, Egypt. It aims to find the correlation exists between people familiarity with ICT and changing behavioral patterns. It is concluded that smart cities have great consequences on changing patterns of urban behavior, city spatial structure and urban social sustainability. The research recommends smart design guidelines using social, communicative, and collective activities to mitigate any expected social risks of smartness.

Keywords: Smart City, ICT, Urban Space, Urban Social Sustainability, Urban social behavior.

المدن الذكية: تحديات الاستدامة الاجتماعية في الفراغات العمرانية؟
تقييم تأثير تكنولوجيا الاتصالات والمعلومات على تغير أنماط السلوك العمراني في الفراغات العمرانية في مدينتي – مصر.

ملخص البحث

تعتبر المدن الذكية أحد الأفكار الجديدة التي قد يكون لها تأثير على المدن المعاصرة. فقد استغلت المدن الذكية تكنولوجيا المعلومات والاتصالات لتحسين جودة الحياة. على الرغم من تطلعات المخططون والمطورين والتكنولوجيين والدولة امال كبيرة على المدن الذكية في تحسين جودة الحياة، الا ان تأثير المدن الذكية على التغير طويل المدى في الحياة الاجتماعية وتغير الانماط السلوكية للحركة العمرانية والأنشطة العمرانية والشمول الاجتماعية وبالتبعية على الاستدامة الاجتماعية في المدن المعاصرة لم يتم تناولها بشكل متكامل حتى الان. فعلى الرغم من توجه بعض الباحثين ان التحول من العمران التقليدي الى العمران الذكي قد يكون له دور في تشجيع الأنشطة الاجتماعية في الفراغات العمرانية، الا انه على النقيض يناقش البحث تأثير زيادة اعتياد السكان على تكنولوجيا الاتصال والمعلومات على تولد أنماط جديدة من السوك العمراني التي قد تكون حاجز للاستدامة الاجتماعية في الفراغات العمرانية. وهو ما يسعى هذا البحث الى تناوله للتأكد من اتخاذ الاحتياطات اللازمة لتقليل التأثيرات السلبية على الاستدامة الاجتماعية. يتناول البحث دراسة حالة لثلاثة حدائق عامة في مدينة مدينتي. يهدف البحث لاستقراء الترابط بين اعتياد السكان على تكنولوجيا الاتصالات والمعلومات في المدن الذكية وتأثيرها على تغير السلوك العمراني. وقد توصل البحث الى ان المدن الذكية لها تبعيات على تغير السلوك العمراني للسكان وبالتبعية على الاستدامة الاجتماعية. وتوصل البحث الى مجموعة من التوصيات للمدن الذكية التي تشكل توائم المخاطر الاجتماعية المتوقعة وتحفز السلوك الاجتماعي بإعادة العلاقة بين السكان والفراغات العمرانية وبين السكان وبعضهم البعض.

الكلمات الدالة: المدن الذكية، تكنولوجيا الاتصالات والمعلومات، الفراغ العمراني، الاستدامة الاجتماعية، السلوك العمراني.

INTRODUCTION

Along history, technological revolutions have caused a seen, deep, side, and after-effects on both urban social life and urban form of cities. Starting with 1st and 2nd Industrial Revolution which adopted machine engine and automobile to cause vast expansion of spatial configuration of city urban form to 3rd industrial revolution of automated production using computers followed by 4th industrial revolution of information and communication technologies (ICT) to raise the challenge of their

impacts on more increase of spatial distance of city spatial configuration. And raise the challenge of how it will emerge new urban behavioral patterns in contemporary cities.

Most research concern smart city put technology as their main interest and do-little interest to human aspects. They concern benefits of ICT including Wi-Fi with infra cables network, Internet Of Things IOT, Closed-Circuit Television CCTV, surveillance cameras, access control and others to enhance the quality of urban life. It aims to monitor and give real-time feedback for civil defense, security and crime, traffic, medical units, and other governmental services. Furthermore, it includes smart meters to monitor, measure and optimize the consumption of resources (water, electricity, and others). Furthermore, end-user applicants for real-time tracking of cognition, route planning, weather and environment, areolation, and parking lanes that could make them respond and take decisions for planning their day where to go and the way they will use to reach destination. Furthermore, traffic monitoring and smart parking that provides solutions for traffic cognition, waste disposal management, safety and security, smart utilities management of lighting, waste, and water. It also provides high E-connectivity to enable E-shopping, E-working, and E-learning (Emam, A. 2017; Fu et al. 2004, Gath-morad et al. 2017, Colldahl, et al. 2013, Radwan, et al. 2018).

Furthermore, recent group of research highlighted design strategies to use ICT to support social interest for inclusion to urban spaces (Stadler, 2013; Abdel-Aziz, 2016 ; Souici, 2015; Costa, 2015; and Hampton, 2008, Hugoton, 2010). Stadler (2013) argued for the ways that make ICT can increase the attractiveness of urban spaces to encourage people inclusion to urban spaces by integrating (positioning service, digital display, mobile communication, augmented reality) to support the performance of public art urban spaces, games and entertainment urban spaces, and educational urban spaces, and information and communication. He depends on ICT and augmented reality to bring new visual and sensual dimensions to public art spaces to support its role to encourage inclusion. Abdel-Aziz (2016) argued for digital interactive media, interactive public display, smart phone applications in urban spaces to support the education and culture, art, games-entertainment, design-planning, and information-communication.

Hampton (2008) and Costa (2015) argued that ICT challenge urban designers to meet needs of people and provides them with interest to attract them, Paris provides different kinds of intelligent street furniture, digital harbor, designed with tablet and laptop computers, and offer WiFi, with charge tools for the batteries of mobile, tab, and laptop, and multimedia devices with solar energy. Hugton (2010) argued for strategies that could enhance ICT to improve social participation. Souici (2015) argued for replacing older activities with new more attractive activities that can gather inclusion and support interaction. They aimed to mitigate the relation between people and urban spaces to encourage involvement to urban spaces.

In contrast, this research shed light the negative consequences that ICT could have on city life by imposing more spatial distance between residents and reduce their interest in inclusion and relation to urban spaces. It gives attention to the transformation of behaviors-lifestyle-culture and change in patterns of social life, spatial use, consumption habits, and social interaction and communication. ICT could make Long-term change in social habits, social behavior, movement behavior, and could have negative impacts on urban social sustainability. Smart technology could make deep changes from simple, direct, and primary behavior to complex, indirect and secondary behavior in production, education, shopping, communication, transportation, movement behavior, and social behavior (Dhere et. al., 2019).

Worldwide, smart city passes the stage of discussion and reached the stage of implementation and examination including planning, construction, and occupation. On the contrary the experiment of establishing smart cities in Egypt is totally new, and needs more time to be built, occupied, and examined. Lately, the Egyptian New Urban Communities Authority adopted the smart city concept to develop the 4th generation of new settlements in Egypt including New Administrative Capital, New Alamein City, New Mansoura City and others based on ICT technology (Abou-elseoud, T. 2019).

Another experiment of Madinaty, a gated community in New Cairo, developed by The Talat Mostafa Group (TMG) who signed, in Jan 2019, a partnership with Huawei Technologies leading global ICT solution provider management and operation to start and accelerate digital transformation of living in Madinaty with the latest technologies in smart cities. They opened the door to apply the latest smart technologies in management and operation like security solutions, surveillance and security systems, smart lighting units, waste management infra cabling, and WiFi. Furthermore, Telecom Egypt TE provides the latest communication technology and next generation network that allows voice and data services alongside entertainment, advertising, and security applications. It will enable Madinaty' residents to have triple play, interactive internet-based TV, video conference and high-quality voice calls using fiber-optics.

The Egyptian government and developers accelerate the digital transformation to face the novel COVID-19 pandemic. ICT is no longer a luxury, but a cornerstone of future smart cities. COVID give ICT the chance to accelerate the emergence of new paradigm of change to apply the concept of smart city. It is expected that the change in behavior will continue after the pandemic end, and people will used to benefit the change especially the reduction of movement behavior.

The research aim: This study aims to tackles the impacts of ICT on behavioral changing in people urban lifestyle, and consequently to predict its relevant impacts on urban social sustainability; and to deduce and predict this impact on shape, form, and spatial organization of smart cities; in order to develop social guidelines in Egyptian smart cities that face the expected social risks that might transform smart cities into less social environment that discourages social inclusion, interaction, and participation, and to motivate social behavior towards socially, healthy, and living city fabric.

In order to achieve this goal, the research aims to answer the following questions:

1- How can ICT establish new patterns of behavior in home, work, education, urban activities, mobility, and the way they participate and interact with each other?
2- How can ICT change city spatial structure and urban space requirements?
3- How can ICT used to improve the quality of urban life with minimum side effects and how ICT strength or weaken urban space?

The research hypothesis: The main hypothesis assumes that the emergence of ICT will emerge new types of social behavior in cities and cause long-term behavioral change in people urban social habits including change in behavioral patterns of social activity (passive, and active, virtual and physical, individual and collective); change in behavioral patterns of urban mobility (travel demand, trip distance, trip frequency and mode choices), and change in behavioral patterns of social (inclusion, interaction, and participation) that could have negative impacts on urban social sustainability of cities and could cause changes of urban form and spatial configuration of the city. In contrast to arguments for the positive consequences of ICT on the quality of urban life and sustainability, this research argues that smart cities rather than enhancing the quality of

urban life and social sustainability it could have great negative impacts to long-term social sustainability. It highlights the social risks and negative consequences of smartness and give clear explanation of their impacts.

The research methodology: The novelty of smart cities in Egypt, makes any empirical study based on location might not be able to represent impacts of ICT on the way residents interact with each other and participate in social life. Accordingly, the research extends the examination of smart city beyond physical provision of smart ICT tools to the concept of people familiarity with ICT. This research deals with smart city as concept embedded in people who become familiar with ICT as part of their daily-life and recently forced to make ICT involved into their life totally or partially as response and solution for meeting new obligations of social distance by Covid19.

The research depends on deductive comparative method using observation and questionnaire to collect data in three parks in Madinaty. The observation aims to measure, predict, and give explanation of how people urban behavior vary by changing people familiarity with ICT based on two steps: First, by gathering two groups of data, the first regarding people familiarity with ICT, and the second regarding people urban social behavior. Finally, detecting the correlation existing between them.

1. SMART CITY vs. CONVENTIONAL CITY

Smart city is a powerful phenomenon that use ICT to manage city processes to improve the quality of urban life, the efficiency of urban operation including waste management, traffic management, the resource management (water, electricity, natural gas, etc.) and achieve environmental efficiency. ICT is a new digital layer added to the city to bring their components i.e., buildings, streets, infrastructure, and urban spaces to life to make city simulate smart living organisms and to have self-organized evolving behavior. Internet platforms, smartphone and tablet applications, and social media platforms have been widely applied in the monitoring, operation, and management of city. It provides access to travel information, planning tools, opportunities to share transport modes, compare transport mode cost, make payment, improve safety and health, and to communicate travel patterns. To achieve this goal, it receives input from different stimulus to move data over network and stored in the data center to be manipulated by mega processor and artificial intelligence (Kumar et al. 2020, Abou-elseoud, T. 2019).

1.1 Analyzing the Conflict between Conventional Versus Smart City

Smart city uses ICT, IOT, and social media to distinguish its singularity from conventional city in the following characteristics and as summarized in table (1):

1- Reduce materiality and introduce virtuality by increasing time over distance, location, and space using the internet to turn from paper to paperless community and turn from physical rooming to virtual rooming. It reduces not only objects materiality but also reduces the human materiality where physical present is not needed any more, every-thing can reach residents without leaving home. It changed the character of acting some activities.

2- Reduce location limitations by the turn from fixed wired internet in work and home that engage people to fixed location, to increase time over space limitations using WiFi, WLAN, HOTSPOT that enables high speed wireless internet access using portable individual mobile devices e.g. Smart mobile, laptop, and iPad devices that give a chance for residents to access internet in public spaces including streets, squares, and parks; and give people chance to make virtual activities instead of

physical one not only at home but also at any other location beyond home and work. Workers who have no interest to work from fixed place all day.

3- The turn from location-based to interest-based: ICT diminish activities in urban space, most activities turned to E-working, E-education, E-shopping and other forms of activities that can happen in hybrid communication using virtual-rooming from home, without need for physical presence. This change make urban spaces are not interesting for residents' accessibility, they hardly have interest to commute in urban spaces. ICT cause resident's loss of interest towards a public space.
4- The turn form rigid to adoptive real-time navigation, mapping and monitoring of people, things, and resources using geographic positioning systems GPS, internet of things IOT and based on statistical analysis to predict the pattern of behavior and consumption as a step to give reactive and proactive responses. This could transform people movement behavior and could challenge planners and urban designers to consider urban mobility in their design and guidelines to achieve sustainable urban mobility.

Table (1). Difference between Normal and smart city

	Normal urban space	Smart urban space
	Paperwork	Paperless community
Materiality	Physical rooming	Virtual rooming
Time-location	Time and location are a must	Only time - Death of distance and urban space
Facilities	Streets, landscape, hard scape	CCTV, WiFi, Access Control, signage, etc.
	Rigid	Realtime Monitor and Evaluation
	Fixed plan	Collaborative and Adoptive
Equipment	Street furniture, stage, street vendor	Smart infrastructure, waste management, free WiFi, lighting management, smart meters.
Activities	Active and passive activities (Gathering and socializing)	Effective activity with supporting information
Mobility	Physical movement of people	Telecommunication

Source: Author

The preceding main characteristics can transform the relation between people and places and between people and each other; accordingly, it could challenge planners and urban designers to consider virtual places as well as physical place in their design and guidelines to achieve urban social sustainability. This could give some explanation of how ICT could develop a new field for new patterns of behavior in communication, interaction, supply and receive information. Accordingly, it could give an expectation of how ICT will impact people urban social life, socio-spatial relations, how they connect to each other and to the city and how to reduce their needs for copresence of contact and accordingly it could pave for guidelines of how to design smart cities.

1.2 Question of Sustainability in Smart City

A wide claim for the great positive impacts that smart cities and ICT could have on urban sustainability. Functionally, ICT can enhance efficient and sufficient provision of services e.g., police, fire, and ambulance services to respond in real-time. IOT and GIS can facilitate daily commute and parking management; traffic flow is monitored and adjusted based on real-time data. It could reduce private reliance on private transportation using integrate functions like trip planning, ride sharing, On-demand transportation, and car sharing. Using real-time navigation to give an alert for drivers about traffic jams locations and the expected delay time and accordingly give them choices of alternative low traffic lower delay routes. Beside they use statistical analysis to predict to anticipate commuting patterns using statistical analysis and anticipate when and where traffic jams will occur. Mobile application e.g., shortest route application provides e-guide to enable drivers to choose less congested routes, short

time over short distance routes, to reduce commute time, cost, and effort, and reduce air pollution, traffic cognition, and cost of travel resource consumption (Zawhil, 2017).

Furthermore, ICT can facilitate the implementation of different security camera and access control tools to real-time inspection and active surveillance and control crime, theft, and robbery, beside safety against homicide, fires, and road accidents and smart surveillance. Public safety is monitored and adjusted based on real-time data. Crime agencies use crime real-time mapping to build statistics and expectations that anticipate crime rate patterns and based on statistical analysis they can face crime before it happens. ICT can encourage environmental sustainability by facilitating the reduction of the impact of the built environment on human health and the natural environment. First ICT provides real-time monitoring of energy, water, and other resource consumption, to increase efficiency in using, minimizing, saving, reusing, storing, recycling, reserving, and gathering resources. Second, provides real-time monitoring and control of waste and pollution output of heat, air, noise, and water. ICT improve public transport, give accurate traffic reports, or provides real-time energy consumption data. ICT Track resources consumption using smart meters and sensors to help control consumption and predict and prevent leakage. Beside waste control and management, and pollution measurement and preventions (Emam, 2017; Fu et al. 2004, Radwan, et al. 2018, Velibeyoglu, et al. 2006).

The impacts of ICT on cities in-terms of providing smart infrastructure to enhance environmental sustainability, energy reductions, pollution reduction and using sustainable energy alternatives is not enough; rather the research extends to the social dimension of sustainability, it aims to detect how ICT could impact patterns of urban behavior including patterns of urban mobility, patterns of social activities, and patterns of social inclusion to encourage social sustainability. It could raise deep change in contemporary cities, and raise a challenge for planners' conceptualization of city, and change in theories of city planning and urban design.

2. THE IMPACT OF ICT ON CHANGING URBAN BEHAVIOR PATTERNS

To give clear explanation of the impacts of ICT on patterns of urban behaviour and accordingly on spatial organization of city, three main patterns of urban behaviour will be examined patterns of movement behaviour, patterns of urban activities behaviour, and patterns of urban inclusion and participation behaviour. ICT expected to have the power to establish new patterns of people behavior and change how people can practice their activities in the first place "home", in the second place "work, education, shopping, others", and in the third place of practicing urban activities, urban mobility, and the way people include and interact with each other in urban spaces. ICT could change how people commute in cities, it could change their trip frequency, travel modes, accordingly it could change the character of activities that occur in contemporary cities and could alter its spatial organization. One of such new developed concepts is the emergency of the virtual space that replaces the face-to-face activities to non-physical urban space like virtual rooming, virtual classroom, virtual shopping mall, virtual banking, etc. it can bring business and library into home, as in figure (1).

Ray Oldenburg (1982) argued for the ('third' place), where people spend time between home ('first' place) and work ('second' place), and third place is the public and semipublic spaces between the main two places. It is a social inclusive gathering places where people can achieve the face-to-face interaction (co-presence) and connect with each other, exchange and share their thoughts and ideas and build relationships to

achieve a healthy urban lifestyle and develop social capital. The third place is a physical urban space its main function is to achieve an interaction with eye-to-eye contact and the face-to-face activities.

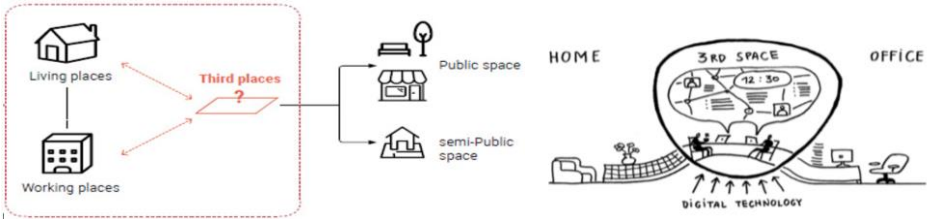

Figure (1). The impact of ICT on living, working, and third places as link between them. Source: (Olma, S. ,2012).

Lefebvre et al. (1991) give clear difference between the public space and the social place as an explanation of the social role of urban space. They argued that the first is the physical and geometric dimension whereas place implies live, social, human experience including the human interaction and gaining meaning and connect to physical space. Place making within physical space always tied to the human experience and emotional relationship than to physical space itself. ICT could change the way we view and interact with physical and virtually world, it could change how we communicate, and it could change needs and requirements and could change the process of placemaking and sense of place from physical to the virtual sense of place.

Hampton et al. (2015) argued that public space is a place for community socialization, a place to chat and doing activities. It depends on the community interaction created to support eye contact between users, conversation opportunity, and socialization. These aspects might be lost (asking people, eye contact, etc.), because of smart city implementation. He argued that smart technology could change social life in urban space. Based on an analysis of video shot between 2008-2010 to study interaction patterns in urban spaces. Moss et al. (2000) argued that ICT with the visual telecommunication will substitute the physical movement of people and services and accordingly will expand the city. ICT will bring library, concert, or business to residents' home. They sought that it would make a dramatic change in spatial organization of activities within the city and may cause death of cities. ICT will eliminate the need for cities as centers of interaction. ICT impacts everyday life including business, shopping, education, and others.

Planners need to think about the appropriate smart city concept, which does not eliminate the upright habits of the community or change the meaning of public space. This paper will discuss the bid of smart city and its implications for shifting meaning of public space. Based on the previous deduced differences between smart and conventional city, this part will drive the impacts of ICT on patterns of urban activities behavior, patterns of urban mobility behavior, and patterns of social inclusion behavior as key factors for tracing the impacts of ICT on transforming social behavior. Urban social behavior like any other social behaviors is based on demand, constraints, and potentialities. The following part will introduce each type of urban social behaviors based on urban theories, their measurement tools will be defined, and the impact of ICT on their change will be deduced, as in figure (2).

As cities change to be smarter, planners are facing a challenge of changing patterns of urban behavior. Assessing how ICT could change patterns of urban activities, urban mobility, and urban inclusion helps to predict its impacts on social sustainability.

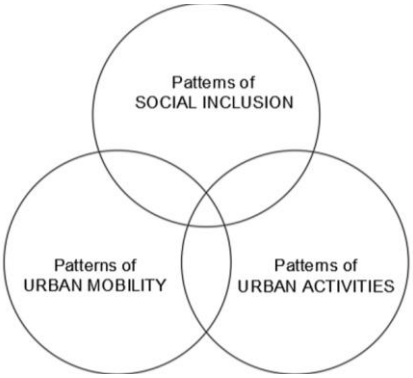

Figure (2). The impacts of ICT on patterns of urban social behavior
Source: (author).

The following framework will be used to criticize the impacts of ICT on changing patterns of urban behavior in contemporary city. Urban behavior is a subjective variable depends on demand, constraints, and potentialities. It concerns the change in typical and repeated way of behaving with urban spaces and with other, it concerns people's intentions, attitude, willing, and interest to exist in urban spaces, what they are more likely and more willing to act. Measuring social behavioral change requires different investigation tools to give clear conclusion including spatial measuring of people behavior, questionnaire and ethnographic observation for mode choices, frequency, duration, and type of doing that activity, as summarized in table (2).

- **Mode Choice of urban behavior:** it refers to the way people willing to do urban behavior. It probes the degree to which residents willing to use certain modes than others with certain duration at certain times of the day.
- **Frequency of urban behavior:** it refers to the times that certain behavior can happen per day. It probes the degree to which residents are willing to repeat certain behavior by certain modes at certain times of the day.
- **Duration of urban behavior:** it refers to the time residents are spending in each behavior per day. it probes the degree to which residents willing to spend more time to do certain behavior by certain modes at certain times of the day.

Table (2). summarized variable for measuring patterns of urban behavior.

Urban activities behavior		Reference
Mode of urban activities	Mode of activity (necessary, optional, and social)	Gehl et al. 2011
	Mode of activities (personal, augmented, and virtual)	Souici 2015, Nassar 2015
Location of activity	1st place (home), 2nd place (work), 3rd place (café, liberary)	Oldenburg 1982
Frequency of activities	Many-times per day, few-times per day, one-time per day	Souici 2015, Nassar 2015
Duration of activities	Short duration, medium duration, long duration	Moss 2000
Time of activities	Early morning, medium-day, late-night	Author
Urban mobility behavior		
Mode of urban mobility	Mode of urban mobility (pedestrian, cycling, private, public)	Bamwesigye, et al. 2019
	Short-distance trip, medium-distance trip, and long-distance trip.	Ghonimi 2017
Frequency of trips	Many trips per day, few-trips per day, one-time per day.	Song 2007
Total trip distance	Long distance, medium distance, short distance	Bamwesigye, et al. 2019
Time of trips	Early-morning, mid-day, late-night	Author
Urban inclusion behavior		
Mode of social inclusion	Unplanned (By-product of movement, Subsidiary of other activity) Planned intended inclusion for (socializing, walking, cycling)	Ghonimi 2021
	(Alone, with friends, with family, work meeting)	Author
	Interaction (No, Greetings, cheap chat, deep social conversation)	Ghonimi 2021
	Participation (Individual, collective, collaborative)	Ghonimi 2021
	(Recognize by sight, know name, build friendship, strong relation)	Ghonimi 2021
Frequency of inclusion	Many-times per day, few-times per day, one-time per day	Souici 2015, Nassar 2015
Duration of inclusion	Short stay, mid stay, long stay	Moss 2000
Time of inclusion	Early morning, mid-day, late night	Author

Source: Author

2.1 The Impacts of ICT on Patterns of Urban Activities

Gehl (2011) classified urban activities into three main types of activities that varies in its way for encouraging people inclusion to urban spaces, necessary, optional, and social activities. Each one can bring social inclusion and interaction in different levels.

- The necessary activities refer to the activities that people have to practice to meet urgent everyday tasks, like shopping, working, and education, and their mobility. It happens without people choices and regardless of the quality of urban spaces.
- The optional activities refer to the activities that people do based on their desire, like walking, playing, and entertainment. Unlike necessary activities, optional activities depend on the quality of urban space to attract people to practice.
- The social activities refer to the activities that people tend to socialize, like kids playing, friends meeting. Like optional activities, social activities depend on the quality of urban space to attract people to practice social activities.

Measuring patterns of urban activities can be defined using different parameters, such as (modes of urban activities, frequency of urban activities, the duration of urban activities, time of activities, and no. of participants).

- The variable **"Modes of Urban activities"** ICT raise the virtual mode that do not require physical present for people in urban spaces, the augmented mode that share the activity in physical and virtual through virtual rooming; and the physical mode that require complete present of people to establish the activity.
- The variable **"Frequency of urban Activities"** ICT could impact the frequency of activities; it could impact its repeated happen and may be reduced.
- The variable **"Duration of Activities"** It measures residents willing to spend more time practicing this activity in urban space at certain times of day.

Moving from traditional to smart city is expected to change patterns of urban activities and could have great encouragement or barrier for urban daily-life activities. ICT can create new activities, can diminish some activities, can minimize the frequency of some activities, can change the way people used to do some activities. It can move some activities from the outdoor to the indoor leaving the space free of other activities and can move some activities from indoor to the outdoor and can use of internet facilities to substitute some physical activities.

Souici (2015) argued that most activities that happen virtually through internet is removed; most activities that requires preservation by internet is reduced and their frequent trips are minimized; only the activities that necessitate physical attendance is kept in urban spaces. He argued that ICT could make change in the forms of activities in urban spaces. He argued that People's behavior is changing by using new technology devices i.e. ATM machines, smart bill machines, TV cameras etc. In the other hand, using hybrid spaces that are a mix of physical and virtual space and using digital platforms e.g., virtual classroom, virtual shopping, virtual work area could limit the face-to-face interaction. And could change the spatial organization of the city. Furthermore, ICT creates new business concepts like teleworkers, distance working and E-workers who work from home. Moss (2000) argued that ICT will affect events and activities in urban space, it could diminish and substituted some activities and events in urban spaces. He gave an example of the impacts of downloading music from the internet on diminish recorded music industry and keep live music in concert halls that require physical attendance of audiences.

The use of internet facilities has substituted the previously physical stated activities. Some activities can occur throw internet will not need physical urban area. Urban spaces face limitation of subsidiary activities, and byproduct of physical movement between destinations that minimize residents experience of spaces and cause a turn from physical urban space that are based on the face-to-face contact to anti-spatial cyberspace, or virtual space that neglect place over time could diminish some kinds of spaces (malls, school, business, banking, transportation, education) and turn to depend on cyber spaces. Smartness caused a change in the form of urban space, there is no need for physical contact, the information technology impacts the emergence, disappearance, and change of some functions. With virtual spaces (virtual classroom, virtual workplace, virtual shopping) physical presence are not required, residents can shop, educate, and work without need for physical present in architecture and urban spaces.

In business sector, most firms concerned work from home by inducing virtual workplace, including smart banking and smart office buildings. In Education sector, most educational entities i.e. schools and universities aimed to use ICT technology to track students location, class attendance, electronic evaluation connected to the payment of fees, and sending students results with an evaluation report to their parents, on the other side to using hybrid and virtual education to replace the current physical education by inducing virtual classrooms. Educational platform can reduce educational spaces costs. In commercial sector, ICT give the chance for online shopping delivery without need for commuting, virtual malls are induced to advertise and reach customers and deliver them what they want without leaving their homes. Finally, in social domain, digital media technologies create virtual social rooming for social contact e.g., Facebook, Twitter, and others, where people can connect with each other and share information and replace and evade the physical contact in contemporary cities.

2.2 The Impacts of ICT on patterns of Urban Mobility

Human urban mobility is a critical urban behavior that can impact social sustainability. Last two-decade, urban mobility witnessed a paradigm shift from the first paradigm that found efficiency in increasing traffic flow speed, affordability and convenience of motorized transport to a new paradigm that strive for sustainable mobility through accessibility based on 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. Measuring patterns of people urban mobility behavior can be defined using different parameters including travel mode-choices, trip frequency, trip distances, and overall trip distances (Ghonimi I. 2017, Bamwesigye, et al. 2019, Gössling, S. 2018).

- The variable **"Modal Choices"** refer to the degree and frequency residents are willing to use and feel satisfied with certain travel modes than other including (public transportation, private car, walkability, and cycling) during day hours, night hours, till late night. It props the reason of using or not using certain mode in terms of (expense, quality, equality, safety, flexibility, accident risk, fuel cost due to distance and frequency, maintenance cost).
- The variable **"Trip Distance"** refer types of travels based on the trip distance residents willing to drive, by certain modes at certain times of the day. It includes long-distance trips that happen daily for work, education, and health; medium-distance trips that happen weekly for shopping, entertainment; and short-distance trips that happen daily for daily shopping.
- The variable **"Trip Frequency"** refer to the time residents can repeat their trips per week; it probes the degree to which resident found it easy to repeat their trip, by certain modes at certain times of day.

Moving from traditional to smart city is expected to change pattern of urban mobility, it could have a great encouragement or barrier for sustainable mobility. With ICT the notion of location and time are not important. ICT can change modes of mobility, time of mobility, frequency of mobility, and total trips.

Souici (2015) argued that the use of internet facilities and virtual rooming has limited people's daily movement and reduce their interest in inclusion to urban spaces, with ICT it is not necessary to move and commute from space to another to buy ticket or pay bill, to enroll in university or school or training course, to reserve in a hotel, cinema, theater, and online banking. accordingly they will commute less than previous; they will reduce their travel frequency for long distance trips, limit the type of mobility, the frequency of each type of mobility, the distance of mobility, and mode choices. ICTs influence people choose long term change of their urban mobility lifestyle for short-distance shopping trips, and long-distance work trips, it could change mode choice, trip distance, and trip frequency.

Song et al. (2007) argued that ICT will diminish people needs for travel. It will limit travel activities considering travel no longer the only way to go. He found that increasing internet connectivity for travel workers will not decrease travel consumption, otherwise it will increase travel consumption due to increased home delivery. It is expected to reduce mobility of people by substituting physical communication in work, education, shopping, and others with virtual communication using teleworker in virtual workplace, virtual classes, virtual shopping. ICT will substitute less important trips for shopping or leisure activities.

Regarding the long-distance work trips, it is expected that the total trip length per day will be reduced, residents have limited willing to move. ICT caused a significant reduction of average trips per day and a significant increase of average distance per trip. For leisure and shopping, ICT caused a significant increase of trip distance and a significant reduction in trip frequency. He found that ICT substitute smaller less important trips for leisure activities. ICT and mode choices: the impacts of ICT on mode choices between walkability, cycling, car, and public transportation for long distance.

2.3 The Impacts of ICT on Patterns of Social Inclusion and participation:

Measuring patterns of people social inclusion behavior can be defined using different parameters. Ghonimi (2021) argued for three patterns of social inclusion to urban spaces, the active as intended social behavior, passive as a subsidiary activity for other attractive activities, and passive as a byproduct of movement behavior.

- Social intended active vs unintended passive inclusion:
  - The variable **"Active intended activity"** refers to planned social inclusion for the intended purposes which is limited without proper interest to attract residents.
  - The variable **"Passive subsidiary activity for other activities"** refers to social inclusion as accidental, unplanned, and causal encounter and passive activities.
  - The variable **"Passive byproduct of movement**" refers to social inclusion as accidental, unplanned, and causal social encounter as by product of movement.
- Collective vs individual interaction and participation modes.
- Individual and collective activities, work concern and conversation concern.

Moving from traditional to smart city is expected to have a great encouragement or a great barrier to social inclusion to urban space. Urban space in smart city achieves limited inclusion due to three reasons, first: it excludes activities that can happen online including activities that required prerequisite trips for preservation like cinema, theater,

hotels now people can use online preservation. Second, it excludes activities that depend on virtual rooming and do not require personal presence e.g., virtual classroom, virtual retail, and virtual work. Third, it excludes urban mobility behavior including low-frequent trips, and non-frequent trips. The limited inclusion minimizes the face-to-face contact and could negatively impacts urban social sustainability. Social interaction is reduced based on limitation in the purpose residents need to exist in urban spaces.

ICT could impact resident's behavior and make them do what is good for them, regardless its consideration or conflict with planners or social sustainability objectivity and what is good for all community. Accordingly defining how ICT could impact resident's behavior and tracing their emergence of new patterns of urban social behavior and consequently emergence of changing patterns of urban structure of the city will be the first step for planners and decision makers to develop regulation and guidelines that can meet community requirements and coincide with planners.

3. A CASE STUDY OF MADINATY PARKS

The experiment of establishing smart cities in Egypt is totally new, and needs more time to be built, occupied, and examined. Lately Egyptian authority adopted smart city concept to develop the 4th generation of new settlements based on ICT technology to accelerate the digital transformation to face the novel COVID-19 pandemic. On the other side, TMG holding signed two partnerships, the first with Huawei Technologies to provide latest ICT solution for management and operation and second with Telecom Egypt to provide next generation communication technology using fiber-optics. Madinaty is selected as a case study to test the validity of the impacts of ICT familiarity on changing people urban behavior in urban space, for different reasons:

1- The novelty of the implementation of smart city in Egypt, where most of the Egyptian 4th generation cities are still not built or occupied. On the other side, TMG in Jan 2019 starts a process of digital transformation to use smart technologies.
2- Madinaty is a fully occupied communities that provides high diversity of social, income and education, that can represent a diversity of familiarity level with ICT.
3- Selected parks provide a complete opportunity for all groups of people who are willing to include, interact and participate in urban spaces, accordingly, any recorded deviation due to ICT familiarity can be interpreted.

Most previous research has developed physical dimensions for measuring smartness of the city. Yet, this research assumes that the concept of smart city is a matter of people familiarity with ICT and is embedded in people not the infrastructure. The research moved the selection of case study from a comparison of variation in the physical domain of different cities that provides different levels of physical ICT tools, to the human domain of different groups of people who have different levels of familiarity with ICT tools as suitable in the case of Egyptian context.

To achieve the aim of this research, two interlocking stages are applied, the first depends on a classification of degree of people familiarity with ICT, and the second depends on the questionnaire and observation of residents regarding the impact of ICT on people social behavior, movement behavior, activity behavior and expected impacts on city form. The case study is based on observation of the central park, the south park, and open-air mall park to trace residents' behaviors in urban spaces, as in Figure (3,4).

a) Madintay location in reference to GCR b) Selected Parks in Madinaty

Figure (3). Location of Madinaty and location of Selected Parks.
Source : ([Photograph of Location of Madinaty and location of Selected Parks], 2020).

c) South park d) Central park e) Open air mall Park

Figure (4). Selected Parks.
Source : Author.

3.1 Data Gathering tools

Data collection were conducted from 1 to 30 November 2020. Two forms of data were collected, the first measures people familiarity with ICT in their urban life, the second measures the change in patterns of urban behavior, finally, the correlation between both is deduced. The study used 7 dimensions for measuring people familiarity with ICT divided into 37 attributes. On the other hand, the change in people behavior is measured using 7 dimensions divided into 25 attributes that measure the behavioural change in people urban mobility, activity participation, and social inclusion and interaction. Measuring social behavior is a critical issue that requires different investigation tools. The case study depends on two types of data collections to give clear conclusion for measuring social and human behavior, both tools provide validation for each other.

3.1.1 Ethnographic observation of visitors' behavior

Ethnographic observation is used to observe the social behavior and urban daily-life activities (Low et al. 2005). The data were gathered in sheets three times a day 10 am to 12 bm, 3 to 4 pm 7 to 8 pm. The observation defines visitors' type, number per day, the way they visit (individual, double, collective), the activity they practice (shopping, entertainment, work, conversation), and the smart mobile devices they use, Figure (5).

Figure (5). Different patterns of social behavior in Madinaty.
Source: Author

Familiarity with ICT causes new behavioral patterns of activities and inclusion as follows:

- Observation of patterns of activities revealed a concern to individual necessary activities based on teleworker. people tend to individually exist in urban spaces to practice individual activities alone using laptop, phones, and tablet to do their works or study.
- Observation of patterns of activities revealed a great concern to smart phone, taps, laptop away from the wide spectrum of physical communication with vital urban spaces.
- Observation of patterns of activities revealed a great concern to private modes of mobility for short and long trip distance.
- Observation revealed a turn in the patterns of inclusion from group inclusion for entertainment and socialization to individual inclusion to be alone to have free time to do their job, where urban spaces become a workplace.
- Observation revealed a turn in the patterns of participation from collective participation to individual participation where most visitors prefer work or finish their study.
- Observation of patterns of interaction reveals a limited conversation with great concern to individual use of laptop, mobiles, and iPad. They prefer to look from narrow screen of laptop and smart phones than to look from a wide spectrum of physical communication.

3.1.2 Questionnaire and Interview

Questionnaire and interviews are administered to a sample of 40 visitors of each of the case study areas. The visitors are randomly selected in each case of adults. Integrators are asked to rank their answers on a five-point Likert scale (1 to 5) ranging from 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. This scale was used to compute each social indicator, and the average scores have been calculated using central tendency using mean score to represent recorded scores for each indicator.

3.2 Data Collection and Classification

Based on observation and questionnaires, data related to the variables are gathered, scored, and classified for each attribute of people familiarity with ICT, and each attribute of the change in urban behavior, the average scores are presented in percentage. A central tendency is used to represent recorded scores for each indicator.

3.2.1 Measurements of Participants ICT-Familiarity

Participant samples have been selected to examine their behavior about ICT. Smartness of participant samples were measured using questions on their daily-life use of ICT:

- Degree and frequency of having smartphone, iPad, and laptop.
- Degree and frequency of using fixed socket, Wi-Fi, internet access via private bandwidth, use public WiFi and Hotspot, time of using internet per day.
- Degree and frequency of having digital social media account (Facebook, Twitter, skype, WhatsApp), emails account e.g. (Gmail, Yahoo, Hotmail), conference meeting accounts e.g. (Zoom, Microsoft team, conference platform).
- Degree and frequency of using virtual rooming in work, learning, banking, and shopping.
- Degree of using weather guide, traffic cognition detectors (shortest road applications), and using transportation application (Oper, Karim, Swivel). Use online tickets registration and payment for trains, Use GPS route finder for defining locations and routes to use.
- Degree and frequency that your children practice education over distance using virtual classroom, Frequency of learning over the internet, and learning management system LMS to communicate educational with school.
- Degree and frequency of using I-banking services, Visa and debit card, Online payment.
- Degree and frequency of using online shopping, you used to pay using debit card and visa card, and online ticket registration and payment for theater, cinema.
- Degree of using ATM, Debit Card, Credit Card, I-banking, online payment, WiFi, HOTSPOT, QR scanner and barcodes, GPS, GIS, LMS, Virtual Classroom.
- Degree of working over distance using the internet, Frequency of working over distance via the internet, and You like to arrange meetings over virtual room than physical meeting.

These measures are gathered, measured, and scored as in table (2). Cluster Analysis is a classification technique used to group entities (people ICT familiarity, in our study) in clusters which are internally homogeneous and heterogeneous among themselves for forming homogeneous groups within complex data sets. Three groups of ICT familiarity are deduced, group (A) high familiarity, group (b) moderate familiarity, and Group (c) low familiarity. This classification is used to deduce the correlation between resident's degree of familiarity with ICT and their urban social behavior in term of travel behavior, activity behavior, and inclusion and participation behavior.

Table (3). Residents' familiarity with smart technology

ASSESMENT RESIDENTS' SMARTNESS		Variables AS OBSERVED OR ASKED		
		Group (A)	Group (B)	Group (C)
Smart Mobile Devices	I01 You own smartphone (times/day/type)	5	5	4.5
	I02 You own iPads and tablet (times/day/type)	4.8	3.6	2.1
	I03 You own laptop (times/day/type)	4.8	3.4	2.5
Social media Platforms	C01 You have E-mail account (Gmail, Yahoo, Hotmail)	5	4.8	4.6
	C02 You have social media accounts (Facebook, Twitter, skype, WhatsApp)	5	5	5
	C03 You have mobile applications (Zoom, MS Teams, Conference Platform)	4.6	3.5	2.4
Internet Access	I01 Using fixed socket, WiFi at home (Likert 1-5)	5	4.2	3.9
	I02 Internet access via private bandwidth (times/day/type)	4.6	3.4	3.2
	I03 Use Public WiFi and Hotspot (Likert 1-5)	5	4.3	2.1
	I04 I use Internet in hours per day (Likert 1-5)	4.6	3.4	1.8
	I05 Wi-Fi is important for choosing where to go (Likert 1-5)	4.9	3.4	1.2
Day-plan solutions	D01 Using weather guide to determine cloths (Likert 1-5)	4.6	3.4	2.1
	D02 Using traffic cognition detectors (shortest road applications) (Likert 1-5)	5	4.3	2.1
	D03 Using transportation application (Oper, Karim, Swivel, ….) (Likert 1-5)	4.6	3.4	1.8
	D04 Use online tickets registration and online payment for trains (Likert 1-5)	5	4.2	3.9
	D05 Use GPS route finder for defining locations and routes to use. (Likert 1-5)	4.9	3.4	1.2
Virtual working	W02 Frequency of working over distance via the Internet (Likert 1-5)	4.8	3.4	1.4
	W03 I like to arrange virtual meetings than physical meeting (Likert 1-5)	4.3	2.2	1.5
	W03 Frequency of working from cafe than from home (Likert 1-5)	4.8	3.1	1.2
Virtual learning	E01 Your children practice education over distance using virtual classroom	4.5	3.4	1.4
	E02 Frequency of learning over the internet (Likert 1-5)	4.3	2.2	1.3
	E03 I use learning management system LMS to communicate with school	4.8	3.1	2.3
Virtual banking	B01 Using I-banking services (Likert 1-5)	4.6	3.4	2.1
	B02 Visa and debit card (Likert 1-5)	4.6	3.4	2.1
	B03 Online payment for tickets and others (Likert 1-5)	4.6	3.4	2.1
Virtual shopping	S01 You used to shop using Online shopping for daily needs (Likert 1-5)	4.6	3.4	1.8
	S02 You used to pay using debit card and visa card (Likert 1-5)	5	4.3	2.1
	S03 Online ticket registration and payment for theater, cinema,	4.6	3.4	2.1
Familiar with	F01 ATM, Depite Card, Visa Card, I-bank, online payment (Likert 1-5)	4.3	2.2	1.5
	F02 WiFi, HOTSPOT	4.9	3.4	1.2
	F03 QR scanner and barcodes (Likert 1-5)	4.6	3.4	2.1
	F04 GPS, GIS (Likert 1-5)	4.5	3.4	1.4
	F05 LMS, Virtual Classroom	4.3	2.2	1.3

Source: Author

3.2.2 Measuring the impacts of ICT on resident's urban social behavior

The research aims to detect to what degree ICT cause behavioral change in patterns of resident's urban activity, urban mobility, and urban inclusion as follow.

3.2.2.1 Measurement of the impacts on urban activities behavior

This section pinpoints the impacts that ICT could have on urban activities in smart city. The questionnaire listed the major expectation of how urban activities vary by increasing people familiarity with ICT, and how it could create new patterns of urban activities including activity mode (virtual, augmented, and virtual), as it implies the frequency, duration, and mode of practicing this activity. People were asked to define activities that could be changed due to ICT as in table (4). Furthermore, the questionnaire listed major expectation based on the following measures:

- Mode of doing necessary, optional, and social activities using virtual, augmented, physical.
- Modes of doing 2nd place (work, educate, shop) and 3rd place activities (walking, dogging, socializing) activities.
- Degree and frequency of physical mode of doing necessary, optional, and social activities.
- Modes of doing indoor and outdoor activities.
- Modes of doing individual and collective activities.
- Duration and time of doing activities.

Table (4). The impacts of ICT on activities behavior

ASSESSMENT OF SOCIAL ACTIVITIES		Variable As Observed or Asked		
		Group (A)	Group (B)	Group (C)
Modes of Necessary activities. (Physical – augmented – visual)	Used to stay at home	4.3	2.8	2.4
	Used to work from home	3.8	3.2	2.2
	Used to learn from home	4.6	3.4	2.1
	Used to shop from home	4.1	3.1	1.8
	ICT moved most necessary activities to virtual home	**4.2**	**3.1**	**2.1**
Modes of optional activities (Physical – augmented – visual)	Used to walk	1.3	3.2	4.8
	Used play in urban spaces	1.3	3.2	4.8
	Used to entertainment	2.4	3.1	3.2
	ICT moved most optional activities to virtual home	**1.6**	**3.1**	**4.2**
Modes of social activities (Physical – augmented – visual)	Willing to encourage kids playing	2.4	3.1	3.2
	Willing to encourage friends meeting	1.1	3.6	4.9
	Willing to meet family and neighbours	1.3	3.2	4.8
	ICT moved most social activities to virtual at home	**1.6**	**3.3**	**4.3**
2nd and 3rd place activities	ICT moved second place necessary activities to home	4.3	2.8	2.4
	ICT moved third place social, optional activity to home.	4.1	3.1	2
	ICT limited 2nd and 3rd activities and moved to home			
In between activities	Participate in walking, dogging, and cycling activities	2.4	3.1	3.2
	Participate in urban spaces, parks, and gardens activities	2.4	3.1	3.2
	Participate in third place (cafe, club house, library)	2.4	3.1	3.2
	ICT limited most in between activities			
Modes of optional activities (indoor – augmented – outdoor)	Concern to participate in indoor than outdoor activities	4.6	3.4	2.1
	Concern to set in indoor café than outdoor area.	4.9	3.2	1.1
	Indoor encourage inclusion by providing ICT facilities	3.8	3.2	2.2
	ICT moved activities from outdoor to indoor			
Mode of activities (Individual – pair- groups)	Physically participate in individual	1.3	3.2	4.8
	Physically participate in couples	3	4	5
	Physically participate in group	2	3	4
	ICT moved physical activities to individual			
Mode of activities (Work - discussion- socialize)	Alone to work	4.9	3.2	1.1
	With clients to discuss work	1.3	3.2	4.8
	With colleges to discuss work	1.2	2.7	3.9
	Socialize with neighbors and friends	1.1	2.4	3.5
	Spent time with family	1.3	2.2	3.2
	ICT change activities to work			
The duration of physical activities	Long stay activities	4.9	3.2	1.1
	Medium stay activities	4.1	3.6	2.1
	Short stay activities	1.2	2.2	3.3
	ICT reduced the duration spent in physical activities			

Source: Author

The deduced conclusions give expectations for change in patterns of activities:

- Activities remained as it is in urban spaces and require physical present.
- Activities that will be partially substituted, that exist with limited users or limited trips.
- Activities that disappeared from urban spaces, do not require physical contact.
- Activities that changed the way it happens (outdoor to indoor or public to individual).
- Activities that invented and recognized, e.g. Teleworker, working in café.

3.2.2.2 Measurement of the impacts on urban mobility behavior

This section pinpoints the impacts that ICT could have on urban mobility in smart city. the questionnaire listed major expectations of how urban mobility in short-distance, medium-distance, and long-distance trips vary by increasing people familiarity with ICT, and how it could create new patterns of urban mobility as in table (5). People were asked to rank the expected impacts in each type of mobility to define most selected mode choice, trip distance, and frequency for long, medium, and short distance trips.

- Mode choices of different types of mobility (walkability, private car, public transportation).
- Frequency of different types (long, medium, and short distance trips.
- Most selected mode choice for long, medium, and short distance trips.
- Total trip-distance using public modes, private modes for long trips distance.
- Total trip distance using walkability and motor solution for short trip distance.

Table (5). Recorded impacts of ICT on travel behavior

ASSESMENT OF URBAN MOBILITY		Variable as observed or asked in questionnaire		
		Group (A)	Group (B)	Group (C)
Mode choices for Long-distance trips	Private transportation	2.8	3.7	4.3
	Public transportation	1.4	3.2	4.7
	Walkability and cycling	0.2	0.5	0.7
	ICT moved long-trips to private mobility	**4.4**	**7.4**	**9.7**
Mode choices for Medium-distance trips	Private transportation	3	3.2	3.4
	Public transportation	1.6	3	3.8
	Walkability and cycling	0.6	1.6	2.8
	ICT moved medium-trips to private mobility	**5.2**	**7.8**	**10**
Mode choices for Short-distance trips	Private transportation	3.2	2.6	2.3
	Public transportation	1.8	2.8	3.8
	Walkability and cycling	1.3	3.1	4.2
	ICT moved short-trips to private mobility	**6.3**	**8.5**	**10.3**
Trip Frequency	Long-distance Trips	2.2	3.6	4.8
	Medium-distance Trips	2.6	3.5	5
	Short-distance Trips	3.2	4.3	5
	Total trip distance	**8**	**11.4**	**14.8**

Source: Author

3.2.2.3 Measuring the impacts on social inclusion and participation behavior

This section pinpoints the impacts that ICT could have on inclusion, interaction, and participation, as in table (6). The questionnaire listed major expectation of how social inclusion, interaction and participation vary by increasing people familiarity with ICT. Different indicators are measured and scored to develop social inclusion indicator.

- Mode of inclusion purpose (intended social interaction, subsidiary for non-social activities, and by product of movement).
- Mode of inclusion manner (alone, with friends, with family, and work meeting).
- Mode of inclusion arrangement (planned and unplanned meetings with friends).
- Frequency of physical inclusion (commercial, educational, economic, and sports activities).
- Frequency of mobility inclusion (walkability, cycling, and active forms of recreation).
- Mode of interaction level (no connection, Greetings, cheap chat, deep social conversation).
- Mode of interaction type (Passive interaction vs active interaction)
- Causal social Counter (recognize by sight, know name, build friendship, strong relation)
- Frequency of (individual, communicative, collaborative inclusion).

Table (6). Recorded impacts of ICT on social inclusion behavior

ASSESMENT OF SOCIAL INCLUSION			Variable as observed or asked in questionnaire		
			Group (A)	Group (B)	Group (C)
Social inclusion mode choice	Purpose	Active intended social inclusion	2.1	3.7	4.8
		Passive subsidiary of other activities	1.2	3.2	4.6
		Passive by-product of movement	1.3	2	4.1
	Integrity	Go alone	4.6	3.3	2.3
		Go with family	1.2	3.8	4.5
		Go with friends	1.2	3.8	4.5
		Go with colleges	1.2	3.8	4.5
	Interest	Interest for physical shopping	1.3	2.4	4.5
		Interest for physical entertainment in parks	1.4	3.2	3.5
		Interest for physical training in club	3.2	3.4	4.5
		Interest for physical social engagement	2.1	3.5	4.6
Social interaction mode choice	Causal encounter	Intentional planned interaction	2.1	3.4	4.6
		Accidental un-planned interaction	1.2	2.4	4.2
		Communicative activities	2.1	3.4	4.6
		Telecommunicate activities	1.2	3.8	4.5
	Intimacy	Recognize by sight	1.4	3.2	3.5
		Know their name	2.1	3.4	4.6
		Build friendship	1.2	3.8	4.5
		Strong relation	2.1	3.4	4.6
	Strength of social relations	No connection	4.6	3.3	2.3
		Greetings	2.1	3.4	4.6
		Cheap chat	1.8	2.1	3.6
		Deep conversation	2.2	3.1	4.3
		Arranged meetings	3.6	3.3	3.8
Frequency of participation	Participation	Individual participation	4.6	3.3	2.3
		Collective participation	1.2	3.8	4.5
		Collaborative participation	1.2	3.8	4.5

Source: Author

4. RESULTS AND DISCUSSION

Based on the collected data, this part aims to define how people's ICT familiarity impacts people patterns of urban social behavior in terms of urban activities, urban mobility, and urban inclusion. It aims to detect patterns of social behaviour, in order to deduce their impacts on planning and impacts on the long-term social sustainability.

4.1 The impacts of ICT on patterns of social activities behavior

People familiarity with ICT records more willing to change urban social activities behavior. The following part compares different patterns of activities mode-choices across different types of groups:

4.1.1 Pattern of activities in term of virtuality

Figure (6) reveals that increasing people familiarity with ICT is associated with great turn from physical to virtual modes of doing necessary activities including work, education, and shopping. ICT moved necessary activities to home. Optional and social activities also record turn from physical to virtual modes.

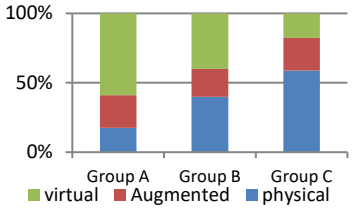

Figure (6). Activity Mode Choices. Source: Author.

It seems that people limited participation to necessary activities, make them lose interest to physical participation in optional and social activities. They used to do necessary, optional, and social activities virtually from home.

4.1.2 Patterns of activities in term of location

Figure (7) reveals that increasing people familiarity with ICT increase total activities done from home on behave of the second-place activities of work, education, shopping, and others. At the same time, it reveals that the total in-between third place activities are highly reduced.

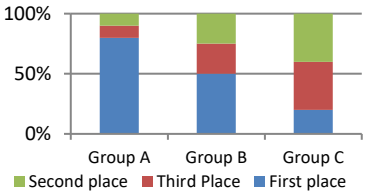

Figure (7). Activity Mode Choices. Source: Author.

It seems that ICT not only moved necessary activities from the second place (work) to the first place (home) where people work, shop, educate, and bank from home, but also it moved the in-between third place activities to home.

4.1.3 Patterns of activities in term of necessity

Figure (8) reveals that increasing people familiarity with ICT reduces total physical activities in urban spaces. It reduces necessary, optional, and social activities. Physical attendance of necessary activities records very low frequency and duration compared to optional and social activities than before using ICT.

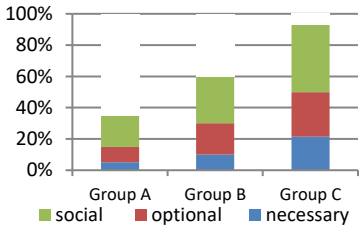

Figure (8). Activity Mode Choices. Source: Author.

Modes of sustainable social activities are reduced with increasing ICT familiarity. Physical activities records 90%, 60%, 35%; divided to necessary 20%, 10%, 5%, optional 25%, 20%, 8% ; and social records 40%, 30%, 20%) accordingly ICT caused a dramatic change in patterns of urban activities.

ICT limits people inclusion to urban spaces, where most necessary activities are not requiring physical present in urban spaces, people can achieve virtually and through online. People tend to stay home to practice most of their necessary activities, they depend on virtual rooming work, education, shopping and other are no longer requiring people physical present, virtual rooming can be enough through internet without need

to get out. It is also associated with low interest in both optional and social activities than before using ICT.

It is concluded that ICT moved most of the activities from the second place to the first place, accordingly it minimizes use of third places and in-between urban spaces as by product of movement between first and second place. Most byproduct activities are reduced, they depend on low frequency for their happen, unnecessary prerequisite trips for reservation are reduced and are not required. On the other side urban mobility of such activities are also limited in term of frequency and physical present.

Observation revealed concern to move most activities from the outdoor to the indoor, they are highly tided to the indoor facilities of electricity, WIFI and high tables to facilitate their use of lab-tops, taps, and mobiles to work in calm indoor area in café. Observation revealed that people have individual concern for inclusion and practice of individual necessary activities based on electronic tools it seems that they prefer to look from narrow screen of mobile phone to communicate with other than the wide spectrum of physical communication. If they are included collectively, they failed to participate in collective activities.

Observation revealed high concern to be alone, a new type of activities has appeared of teleworker who seek the third places with an aim to do their work and study. Some activities change the way it was used to happen, for example Wi-Fi hotspot internet in cafes and public spaces transform them to be co-working places for home workers and freelancers, it attracts people to work in indoor-urban spaces and increase resident's individual interest for inclusion to work and study.

4.2 The impacts of ICT on patterns of movement behavior

People familiarity with ICT records high more willing to change movement behavior. The following part compares changing patterns of travel across different groups:

4.2.1 Travel mode choices in terms of trip distance

Figure (9) reveals that people with high familiarity with ICT records reduced total trip frequency for long, medium, and short-distance trips. They do not need to move long distance trips for work, they are doing work, education, and other necessary activities from home. They become un-willing to travel medium and short distance trips for shopping or entertainment.

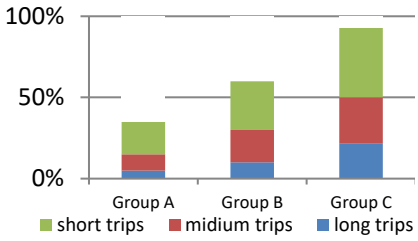

Figure (9). Travel Mode Choices.
Source: Author.

It seems that reduced long trips for necessary activities discourage them to travel medium and short trips for optional and social activities.

Empirical data revealed that increasing ICT familiarity is associated with reduced total travel records 90%, 60%, 35%; including reduced short-distance trips record 40%, 30%, 10%, reduced medium-distance trips records 30%, 20%, 10%; and reduced long-distance trips records 20%, 10%, 5%).

Accordingly, ICT caused a dramatic change in patterns of urban mobility.

- ICT discourage long-distance trips to work, schools, entertainment, shopping monthly needs. Instead, they are willing to depend on virtual meetings and interaction through E-learning, E-working, E-shopping, that limit all modes for long-distance trips.

- Smart city with turn to virtual modes was expected to increase frequency and volume of short-distance trips, it thought that virtual modes in doing necessary activities will make people free to increase total frequency of short distance trips for optional and social activities, rather empirical data revealed that they used to stay home and discouraged short-distance trips, people used to call online delivery that limit walkability, cycling and public transportation in microscale.

Empirical data revealed that total concern for mobility modes is reduced, people do not have the interest for physical inclusion. ICT reduce short distance trips, total short distance trips per day, total trip frequency, less important trips for leisure and shopping, work trips that can be substituted by virtual one, prerequisite trips for reserving cinema tickets, and many other active activities that give chance for social activities to occur in urban spaces.

4.2.2 Travel mode choices in term of mobility

Figure (10) reveals that people with high familiarity with ICT records high rely on private transportation for long and short distance trips. On the contrary, low familiarity with ICT records are willing to use public transportation and walkability. It seems that ICT make people prefer fast travel using private tools than to spent time in public modes and walkability.

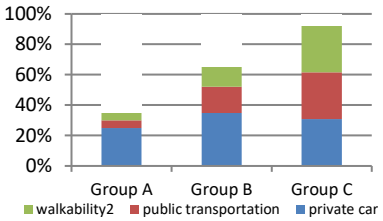

Figure (10). Travel Mode Choices.
Source: Author.

Empirical data revealed that increasing ICT familiarity is associated with turn in mode choices including increased private transportation 30%, 350%, 30%, reduced public transportation records 30%, 15%, 5%; and reduced walkability records 30%, 10%, 5%). Accordingly, ICT caused a dramatic change in patterns of mobility mode choices.

- ICT discourage public transportation and walkability, instead it encourages people to depend on private modes for long-distance trips.
- Smart city with turn to virtual modes was expected to reduce private-car dependency and to make people have the time to use public transportation and pedestrian-mobility, rather empirical data revealed that they used to depend on private modes for long, medium, and short trips.

4.3 The Impacts of ICT on Patterns of Inclusion, Interaction, and Participation

People familiarity with ICT records less willing for social inclusion, interaction, and participation. The following part compares different patterns of inclusion across different types of groups:

4.3.1 Modes of social inclusion

Figure (11) reveals that people with high familiarity with ICT records low interest for inclusion in urban spaces, they prefer doing necessary activities from home, including shop, work, and educate. At the same time, they are not willing to include for optional and social activities, it seems that doing necessary activities from home, make them lost interest for inclusion for optional and social activities.

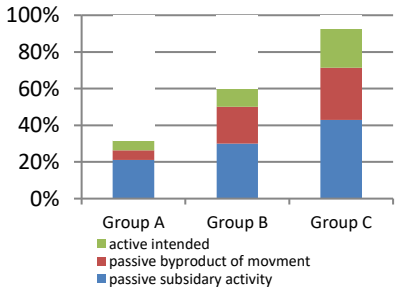

Figure (11). Inclusion Mode Choices
Source: Author.

Modes of social Inclusion varies according to ICT familiarity as follows: The high familiarity with ICT tends to be alone in urban spaces, sometimes they invite co-workers to discuss aspects regarding their work. On the other hand, people with low familiarity of ICT tend to include with friends, family, and neighbors to do collective and collaborative activities including discussion and conversation and sometimes they participate in collaborative activities. Furthermore, it records that most inclusion interest concerns intended planned meetings for inclusion and interaction, and hardly have unintended unplanned meetings, and records that most inclusion interest concerns practicing individual activities and limit collective social activities in urban spaces.

4.3.2 Modes of social interaction

Figure (12) reveals that people with high familiarity with ICT records low interest for all types of collective interaction in urban spaces, they prefer virtual collective interaction. At the same time, they are willing to include alone for doing work or study and have low interest for practicing the conversation, they lost interest to collective interaction and lost interest in building social relations or making speech or greetings with others.

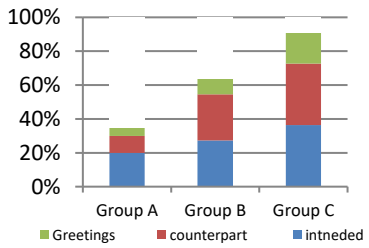

Figure (12). Interaction Mode Choies
Source: Author.

Modes of social interaction, causal social encounter, and social relation are reduced with increasing ICT familiarity (intended interaction records 35%, 30%, 20%; counterpart records 40%, 25%, 5%; greeting records 5%, 5%, 10%). The high familiarity with ICT lacks accidental modes of interaction, they mainly depend on intended modes of social interaction which are limited. They record weak social relations and interaction they hardly know others by sight, their interest orient to the narrow window of laptop, iPad, and smart phone. They hardly give greeting and at worst case make cheap chat, they are more willing to make conversation with others. On the contrary, people with low familiarity of ICT records increased intended active and accidental passive meetings. They are more willing to meet each other, know other, give them greetings, and build strong social relation of strong friendship.

4.3.3 Modes of social participation

Figure (13) reveals that people with high familiarity with ICT records lower communicative activities in urban spaces, they prefer individual activities, they highly prefer telecommunication through internet than the face-to-face participation. They do individual work using smart tools than willing to participate in collective and collaborative activities with others.

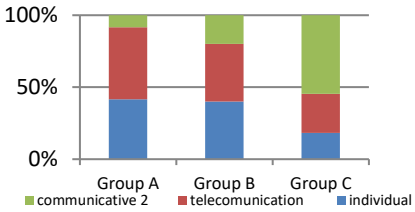

Figure (13). Participation Mode Choices
Source: Author.

Modes of social Participation and collaboration are reduced with increasing ICT familiarity (communicative records 10%, 20%, 45%). The high familiarity with ICT has low concern for communicative activities, that discourages talk and eye to eye contact. Most integrators prefer to virtually see and communicate form the narrow screen of mobile and tablet than to communicate with the real world with the face-to-face contact. That recorded virtual communication and reduced human interaction in urban spaces hiding-behind- narrow screen providing one way connection that isolate users from participate their immediate surroundings.

The analysis reveals an emerged new pattern of social inclusion, interaction and participation in urban spaces, people with high familiarity of ICT come individually

and concern individual activities using ICT internet, laptop, smart phone, and tablet to work. Collective inclusion is limited, they have no interest for collective activities and if happen it mostly concern work and do not include conversation between each other, considering ICT interest in designing urban spaces discourage social inclusion and cause a dramatic change in patterns of people behavior.

5. DEDUCING THE IMPACTS OF ICT ON SOCIAL SUSTAINABILITY

Based on the deduced results regarding the impacts of ICT on changing people urban behavioral, planners need to pay great attention to two groups of conclusions, the first regarding the expected impacts of changing urban behavior on city spatial structure, the second regarding the expected impacts of changing urban behavior on social sustainability as in table (7).

5.1 Predicted Impacts on City Spatial Structure CSS

Based on the detected correlations between people familiarity with ICT and people urban behaviors, the research concludes some relevant impacts on city spatial structure:

The behavioral change in urban activities give new predictions of city spatial structure:

1- The change from physical to virtual rooming reduces all types of activities, some activities could substitute to virtual and disappear from contemporary cities e.g., E-learning, E-shopping, E-banking; other activities will be substituted, that exist with limited users, or limited trips (Partially substituted activities) (augment learning). Finally, some activities will be diminished, that will be disappeared from urban spaces as it does not require physical contact. And other activities will continue to exist in urban spaces and require physical present.
2- The change from fixed internet to WIFI, create new patterns of urban activities that will change the way it will happen, e.g., turn of café to working areas for teleworker and students who tend to practice singular activities of work and study.
3- The emergence of new patterns of activities raises need for design urban space with ICT tools to attract people inclusion and fit to their needs, including WIFI, power sources for charging their smart tools, urban space furniture to meet their needs for using smart mobile sets.
4- E-services reduce the need for physical space to meet people physical present, accordingly most norms of area per occupant, and travel distance need to be revised based on the reduced need for walking to services as people will get services from their homes.
5- Virtual rooming reduces most types of activities and minimize and substitute most physical necessary activities, reduce people willing to do optional activities, and minimize people willing to do social activities. This will reduce possibilities of making urban spaces suitable places for encouraging people involvement and will require new paradigm for design urban spaces to encourage inclusion.

The behavioral change in urban mobility give new predictions of city spatial structure:

1- Limited long-distance trips could reduce traffic flow and reduce feasibility of high standards of street network patterns in term of road width and parking requirements.
2- Minimizing urban mobility to short-distance trips in microscale reduces the need for travel and cause self-contained communities that limits mobility to microscale and discourages mobility in macroscale.
3- Travel distance norms are not key factor as people can get their services regardless without need for travel.

The behavioral change in social inclusion give new predictions for city spatial structure:

1- Virtual rooming reduces mobility in urban spaces; accordingly, reducing the chances that can make people meet each other. This put a challenge for urban planners to design more socially sustainable smart urban spaces that encourage people to include to urban spaces.
2- Virtual rooming reduces active inclusion for social activities and passive inclusion as subsidiary for other necessary activities and reduces passive inclusion as a byproduct of movement to other places.
3- Reduced travel behavior and reduced necessary physical activities behavior will influence people inclusion to urban spaces, accordingly planners are facing the challenge to rebuild and reconnect the relation between people and urban spaces.
4- Reduce collective activities will reduce social interaction in urban spaces, accordingly planners are facing a challenge to relocate social collective activities that can build social relation between people.

Planners are required to change city design criteria to small distance communities that provide interest to make people depend on walkability for most of the travel needs. This could reduce traffic flow, traffic cognition, parking requirements, and accordingly could change most of the design criteria of city planning, streets design could be narrower and limited in parking requirements per occupant. The pedestrian and cycle mode choices will be increased and their standards and requirements for walkways will be increased.

5.2 Predicted Impacts on Social Sustainability Indicators

Based on the deduced change in resident's social behavior, this part discusses how such factors could impacts achieving social sustainability norms including healthy community, sustainable urban mobility, sustainable social activities.

Healthy sustainable cities aim to encourage and increase levels of physical activities, particularly high levels of walking and cycling as an essential factor for resident's health to other social, entertainment and sport activities as a complementary factor for resident's health. Measuring such norms with smart city reveals great fears that ICT have great impacts on reducing physical activities in contemporary cities and reducing trip frequency for short distance trips. Accordingly, ICT could reduce walkability and cycling in public space. Smart city could discourage or create psychological barriers to physical activities that change social behavior towards lower healthy living. WALL-E is one of the leading films that give expectations for future impact of ICT on changing future shape of the human body, due to the limited physical activities that humans do.

Sustainable urban mobility in cities aims to encourage movement behavior that reduces automobile dependency, induces non-automobile and public mobility, increase walkability reliance, travel distance and frequency and reduce motor travel distances and frequency. Measuring such norms with smart city reveals that smart cities reduce long-distance trips accordingly reduce total motorized trip distance. Accordingly, enhance sustainable urban mobility in macroscale. Furthermore, smart cities reduce short-trip distance and could discourage community social interaction and could harm resident physical health. Accordingly, smart cities could have negative impacts on social sustainability in microscale.

Socially sustainable city emphasizes the importance of social networks and social ties and enhance the way it works to assure social relation, integration and especially the

face-to-face co-presence and interaction, safety and security, correlation, cooperation, contraction between people, social inclusion, social equity, and equal opportunities in the distribution of development benefits and costs. Measuring such norms with smart city reveals the role of ICT in establishing channels between residents connecting them to local government and to local community and could make responsive governance and build civil societies and social ties. It gives people a huge opportunity for social interaction using different social platforms to engage friend of similar interest.

On the contrary, great fears that the implementation of virtual rooming is expected to bridge physical relations to virtual online one. Smart cities change long-term human behavior who tend to isolate himself from the public domain and tends to practice most of the activities from home, gradually they could lose the language of public physical participation. This could vanish most of public activities and lost the face-to-face contact and copresence spatial and social distance. They make virtual sense of virtual place over physical places that reduce their interest of inclusion to real physical public space that are less attractive for people, accordingly, it reduces people participation in different activities. Smart cities change interaction patterns in urban spaces, it increases social isolation and increase residents willing to spend time alone in urban spaces.

Smart cities achieve safety based on active surveillance of CCTV and access control, on the other side, it revealed limited passive surveillance by reducing resident's natural surveillance to urban spaces. Accordingly, smart cities need to revise their impacts on surveillance by encouraging natural surveillance as a tool for safety. This emphasis the hypothesis of the research that ICT impacts people urban behavior in contemporary cities to less socially sustainable behavior, ICT reduce people interest and willing to exist in urban spaces, it reduces people willing to physically do necessary as will as optional and social activities, it reduce the relation between people and each other and reduce social inclusion, interaction, and participation. On the other hand, it also supports the recommendations offered by (Stadler, 2013; Abdel-Aziz, 2016; Souici, 2015; Costa, 2015; and Hampton, 2008) who conceptualized the role of ICT tools to support the relation between people and urban spaces by presenting digital interest for their inclusion. Rather the research extends planners challenges to provide activities that not only provide the interest for social inclusion to urban spaces but also to encourage the face-to-face interaction and communicative collaborative participation. The research extends recommendations to more than rebuilding the connection between people and urban spaces, to strategies that relocate social physical communicative collective activities that can rebuild social relation between people and each other.

6. CONCLUSIONS

Smart city is a challenging concept for the future of urban development. It is developed to enhance the quality of urban life in contemporary cities. The way we design contemporary cities will impact our behavior; ICT provide to have great impacts on people behavior in urban spaces. This research gives alarm with empirical evidence of the expected risk that could impose on social life and urban social behavior in urban spaces of contemporary cities. It gives alarm for planners of what expected long term impacts on resident's behavior who might choose to change their lifestyle, to take what should be taken in consideration regarding social sustainability. ICT could change urban daily life habits and long-term resident's urban social behaver including behavioral patterns of movement, physical activity, and social inclusion, cohesion, and security. ICT raises great fears of the negative impacts it could impacts social sustainability and healthy community.

The impacts of ICT on behavioral change in urban behavior patterns raises a deep change in contemporary cities that challenge planners for conceptualization of the future of contemporary smart city. It requires a change in theories of city planning and urban design. The change exceeds the smartness of providing infrastructure techniques for environmental sustainability, energy reductions, pollution reduction and using sustainable energy alternatives; rather it extends to the social vision of sustainability, to face expected change in patterns of urban social behavior that can discourage social sustainability in contemporary cities. It aims to develop strategies that can control patterns of urban mobility, patterns of social activities, and patterns of social inclusion to encourage social sustainability.

The expected risk of smartness will influence people inclusion and interaction in urban spaces; accordingly, planners are facing the challenge not only to provide interest to rebuild the connection and relation between people and urban spaces, but also to relocate social collective communicative activities that can rebuild social relation between people and each other.

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Table (7). The impacts of ICT on social urban behavior and social sustainability

Dimensions	attributes	Deduced impacts of ICT on urban social behavior.	Impacts on sustainability	Recommendation
Urban activities behavior				
Mode choices	Physical-Virtual	Modal shift of activities from personal to virtual and online activities in necessary activities. Limited interest for personal social activities.	Reduced social relations, interaction, and participation.	Provide ICT tools to encourage necessary activities in out-door. Providing attractions to increase interest for social and optional activities.
	Indoor-Outdoor	Modal shift from outdoor to indoor activities to meet their requirement for electric, WIFI and tables to connect to internet.	Reduced role of outdoor urban space.	ICT tools are required in the outdoor to encourage people interest for inclusion to the out-door. Also increasing outdoor activities are required.
	Individual-collective.	Modal shift from collective activities to individual activities.	Reduce role of collective activities in urban spaces. and reduce contact and collaboration.	Encourage collective and participative activities to encourage people interaction and participation.
Change in activities	Activities removed	Activates that can happen online through internet and virtually are removed. e.g. banking, bill payment, E-learning.	Limit the face-to-face interaction. Limit social inclusion. Reduce people daily movement.	Reduced requirements of removed activities and move its spaces to serve another social and optional activities.
	Activities minimized	Activities that reduce frequency are minimized only necessary activities.	People limit to attend events and gathering in indoor activities e.g. restaurants.	Provide Flexible, adoptable, multifunction urban spaces.
	Activities changed the way and rate it happens.	Most physical activities changed to virtual. Most activities done at home. E-learning depend on virtual learning. E-Shopping depend on virtual shopping.	Limited people daily movement. Limited people inclusion to urban spaces. Virtual activities are encouraged than personal activities.	Digital transformation to provide required ICT tools for virtual activities.
		Activities moved from the outdoor to indoor. Leave the space free of activities	Negative impact on social interaction and participation.	Increase urban spaces rates per occupants. Substitute removed activities with social activities.
	New patterns of activities	New patterns of activities are emerged e.g. teleworkers,	Single activities are encouraged over participative activities.	Manage the transition of activities to encourage participative activities.
Movement behavior				
Mode choices	Public to private	Modal shift from public to private motorized modes.	Environmentally – people tend to turn to private mobility which will increase mobility, energy consumption, air pollution, traffic jams.	Encourage small community with mobility within walking distance. Encourage safe cyclability and pedestrian walks.
	Motor to non-motor	Modal shift from non-motorized to motorized especially private.	Limited walkability and public, cause limited inclusion, interaction, and participation.	have safe space for social/physical distancing while getting outside
Trip Distance	Long-distance Trips	Modal shift for minimized long-distance trips that mainly limited to private modes. Minimize unnecessary journeys.	Reduce traffic flow, cognition, and pollution.	New higher standards with wider sidewalks to increase safe space for walking and cycling and reduce car use
	Short-distance Trips	Modal shift for minimized short distance trips.	Limited mobility causes limited inclusion and limited interaction.	Transforming streets to increase space for walking and cycling and reduce car use.
Total-distance trip		Reduced total trip distance.	Limited inclusion and participation in urban spaces.	Design short-distance communities that enable 15min. walking distance for all types of activities.
Social inclusion behavior				
	Inclusion	Reduced inclusion to urban spaces mainly done individually for intended necessary activities and minimized interest for optional and social activities.	Minimized interest for collective inclusion,	Provide ICT tools, WIFI, and Electric power to encourage people for inclusion.
	Interaction	Shift to non-physical, virtual, and online interaction. Shift to individual activities, with isolation.	Limited the face-to-face, physical and personal interaction. Minimized interest for greeting, conversation, and collective activities.	Provide setting area that encourage the face-to-face counterpart and conversation.
	Participation	Limited interest for participation in personal participation.	Minimized interest for communicative and collaborative participation.	Enable mixed use activities that attract collaborative participation.

Source: Author