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Research Paper

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IMPACTS OF DIGITAL TRANSFORMATION ON MOBILITY AND TRANSPORTATION SECTOR- ANALYSIS OF THE FREQUENCY OF MOBILITY USERS BEFORE AND DURING THE COVID-19 CRISIS

Abstract: It is indeed a fact that the digital transformation has been changed rapidly in the last few years, and the appearance of the COVID-19 pandemic played a significant role in accelerating the wheel toward intelligent and digital transformation in all sectors; some countries have been recovered quickly from the pandemic and managed to eliminate most of the obstacles while others still struggling. The public transport sector PT during COVID-19 pandemic was affected directly, which is an inevitable result that disrupted the system. This paper will investigate through an online questionnaire survey the effect of the COVID-19 pandemic and the digital transformation on transportation modes and activities by evaluating the current situation and assessing future transportation sustainability and whether it will continue to recover appropriately. The research will identify user's awareness, attitude, and behavior toward PT before and during COVID-19, as the trend has been in favor of private vehicles and avoidance of PT, therefore increasing confidence in PT requires decisive action from governments, policymakers, and planners to keep pace with the intelligent transformation. Keywords; COVID19, transportation, sustainability, digital transformation, transportation modes, and activities.

Keywords: Digital, mobility, transformation, transportation, Covid-19

INTRODUCTION

Sustainability development is genuinely about achieving a balance between several objectives (Environmental, Economic, and Social), the most robust model when the environmental domain forms the foundation upon which the social and economic pillars rest. Although the transportation and mobility sector is indispensable and considered the nerve of every activity, its

negative impacts drain the infrastructure and impede proper development. Previous researches before the COVID-19 crisis had shown that disruptions can be a catalyst for shifts towards more sustainable behaviors. Still, in the case of the COVID-19, the trend was the opposite by avoiding PT in favor of private vehicles. Sustainable transport should generally be understood as to meets the needs of society without compromising our ability to meet future transportation needs (Horner, 2011). During COVID-19 pandemic, traffic congestions and accidents have been decreased, and air quality improved, so what can be done to keep these gains. In India, Uganda, and South Africa, a study was conducted to assess lockdown restrictions and their impact on communities (Peden & Kobusingye, 2019). As in any other country, people moved to work remotely, and students began online learning, resulting in significant reductions in the use of public transportation. As the end of the lockdown, the transportation sector must regain commuter trust, which can only be done if other sectors work together, particularly the health sector, because public transportation with coronavirus is considered a dangerous atmosphere with the presence of a large number of people in a small space with insufficient ventilation systems, making it nearly impossible to avoid direct or indirect contagion. The transportation and public health sectors share five dimensions, see Figure 1, are Safety, Active Transport, Fresh Air, Connectivity/Access, and Equality. To have a healthy and safe, sustainable system, those dimensions must be harmonious and balanced with each other; equity will represent the central role so that all people have access regardless of age, gender, ability, or income. Private mobility operators also suffered a lot, particularly in low- and Middle-Income Countries LMICs. This also includes those who work as taxi drivers and two- and three-wheelers, tuk-tuks, and so on. Such people often lack health insurance. They would also be at risk of homelessness; the pandemic is an opportunity for governments as well as transport policymakers to stop and look at the challenges and lessons that can be learned and make our transport systems healthier, safer, and more resilient; the epidemic has shown that nothing is impossible and countries can rapidly modify policies are put into actions. The pandemic is an opportunity for governments to seek solutions for negative issues that come to the surface due to COVID-19, such as health and safety issues; the survey assesses passenger range of choices in transport modes and people's travel behavior. Demographic information such as education, age, gender, income, city of residence was collected, and questions concerning work mobility, online shopping, transportation habits, and choices were. According to the survey's findings from India, one-third

of respondents altered their means of transportation for work during the pandemic (Peden & Kobusingye, 2019).

Figure 1: Transportation and health framework (Peden & Kobusingye, 2019)

To investigate the existence of clear guidelines and emergency plans for different transport modes/facilities, a survey is conducted in Turkey by (McKibbin 2020) about aviation systems, maritime systems, rail transit systems, bus systems, taxis, express motor highways, and logistics facilities. The results clearly indicate that there is a certain lack of both emergency plans and public health instructions; the participants have been asked if they found a decrease in public transportation usage to other modes, more than 80% answered that they witnessed a shift to private cars, walking, and bicycles.

LITERATURE REVIEW

Over the past ages, there have been several crises, including health and terrorism causing changes in transport and mobility. The people manage their affairs and business if they have access to remote working and learning, but it is a struggle for others. Alternative mobility must be sought. This will make changes in passenger behavior, attitude, and habits. Many studies, for example, showed that the crisis impact on air transport may be long-lasting even if everything becomes normal again; for example, US domestic air travel was 7% lower after the 9/11 attacks,

demands for mobility after COVID-19 crisis, especially for air transport will change based on several factors including safety, health, risks, mental and physical comfort, availability of alternative modes, government restrictions, and regulations, etc. It is also a fact that the transformation to online and remote meetings and e-learning will become more feasible, resulting in long-lasting reductions in transport demand. According to (Sung & Monschauer, 2020), One of the lessons learned that should be taken into consideration after the pandemic is the investments in sustainable infrastructure for the benefit of PT and non-motorized transport modes, which are the best cost-effective, attractive, and safer modes, this will be a significant improvement for the environment, and that will ensure sustainable transport in the future, in addition, more private cars mean massive congestion, more space for parking and more risk of traffic accidents, unfortunately, causing continues and uncountable loss. The most positive global impacts of COVID-19 had clean air due to the significant reduction in mobility, and that made all creatures happy and grateful (Sung & Monschauer, 2020).

Smart Technology

To examine the impact of COVID-19 on transportation sustainability, socioeconomic, energy consumption, and emissions, (Abu-Rayash & Dincer, 2020) proposed an assessment model for any given city, this intelligence model that has been developed contains four indicators to measure the efficiency, technology integration, traffic congestion, and accessibility rate and it will create various intelligent transportation solutions to achieve environmental, economic, and social sustainability based four data indicator as follows;

- Transport efficiency

It is evaluated by measuring the duration from one point to another, the efficiency duration almost less than 30 minutes, and compared to the total commute times for a specific city.

- Technology integration ratio

It is related to the use of advanced technologies, including AI, cyber technology, space systems, data analysis, and autonomous technologies. It is evaluated by determining the proportion of advanced technology used and the total number of EV charging stations divided by the city's total area.

- Traffic congestion rate

A baseline is considered a free flow across each road to evaluate this indicator. Then, travel times across the entire year are analyzed and compared.

- Accessibility ratio

The accessible ratio represents the total length of the accessible routes in (km) compared to the entire length of roads in the city.

The objective of the model is to evaluate the city's intelligent transportation capacity from a comprehensive approach; the strengths of such a method come from its design and the selected parameters; on the other hand, as (Abu-Rayash & Dincer, 2020) study mentioned, the specialists in the transport field may choose these indicators with suitable modifications to evaluate smart transportation.

Another innovative survey was done by (Nguyen, Saputra, Van Huynh, et al., 2020) of Enabling and Emerging Technologies EET for Social Distancing due to the lack of suitable precautions to limit spread the majority of countries required home quarantine and self-isolate, for a while, this case, of course, cannot be forever so looking for suitable and modern effective future solutions to save time, efforts and achieve sufficient efficiency in the transportation sector to face any pandemic. The study enables emerging technologies and concentrates on using smart cameras visions and sensors for recognition to identify people, assess the situation and social distances, and checking the physical conditions by using Deep Neutral Network (DNY) (Taigman et al., 2014), and definitely the machine learning which can identify and recognize the locations and the nearby pedestrian, the passengers, traffic conditions and the degree of risks in public places even it can develop a mechanism to reduce and minimize both the pedestrians and vehicle delays and maintain peak social distances at stops stations (Zhang et al., 2019), by using Machine learning and AI which is very important in tracking at-risk humans to detect humans with specific symptoms and track infected persons in public places and congestion areas, as well as elder people, to make sure that they are in self-protection areas (Cho, 2016) ,with all this, it is essential to protect and not breach the privacy of innocent and committed people from becoming victims not only from health attacks but also from a cyber-attack, and to do so, data protection mechanisms including data anonymization, randomization, and aggregation should be utilized (Zhou et al., 2018). For example, we can Activate the feature of sensitive information and personal identities in discreet locations to exchange or anonymize, show or hide according to the

person's desire through trusted mobile users to avoid the attackers (Nguyen, Saputra, Van Huynh, et al., 2020); Nguyen, Saputra, Huynh, et al., 2020).

Risk Mobility

To study the risk mobility associated with COVID-19 an assessment of the frequency of modes usage for each facility and activity has been made by (Barbieri et al., 2020) through an online survey implemented in ten countries: Australia, Brazil, China, Ghana, India, Iran, Italy, Norway, South Africa, and the United States during the period from the 11th to the 31st of May 2020, the survey characterized the mobility used of all transport modes before and during government restrictions, in included questions about the risks of catching COVID-19 from different transport modes, the survey conducted in 10 cities all over the world consists of two parts the first is an analysis of the frequency of different ways of usage for each mobility activity including works, education, social and shopping mobility as well as free time and leisure travel, while the second part assessment the risks of catching COVID-19 from different transport modes from the user's perspective (Barbieri et al., 2020). An exciting survey concentrated on the experts in the field of mobility and transportation, which was conducted online for experts in 60 countries, was done by (S et al., 2020); the questions about the transportation and mobility usage, the interrupted modes, facilities, and activities during the COVID-19, the lockdown, recommendation, etc. The big question was about threats and weaknesses and whether the innovative and digital transformation will help the transportation sustainability development. Most experts agree that remote working and shopping will become more controlling in the future. Few people disagreed that private vehicles usage would rise. For example, they said that people will avoid crowded public transport and any other places (avoiding supermarkets and malls) to the benefit of alternatives, for example, small local businesses.

But on the contrary, they suggested that online education will not last. Still, at the same time, the majority believe society will grow more splintered due to intelligent technologies, AI, and digital transformation. (S et al., 2020) study shows that experts who agreed that private cars will increase were from the USA, followed by India, experts in India offer the highest share that society will grow more splintered. Online shopping will gain more attraction in South Korea.

Online shopping in Europe, the USA/Canada, and Japan are evaluated as less than that in other countries/regions. Working hours will become longer in India and other Asian countries. (64.8%) said that considerable changes will happen within the next five years is due to lessons from COVID-19.

Assess The Changes in Travel Behavior

(Bhaduri et al., 2020) studied the changes in travel behavior and transport mode usage with traveler characteristics. In this paper, mathematical models were developed to quantify the effect of the demographic characteristics of the passengers on the mode and frequencies before and during COVID-19. Results show a high shift to online work, shopping, and private shared vehicles. The dependent variable in the model is the weekly frequency of choosing each mode and activity such as work, shopping, leisure activities. Results show that the mode choices of travelers are affected by the demographical characteristics of trip purpose and transport facility e.g.travel time, cost, reliability, etc.; the model used Multiple Discrete Choice Extreme Value (MDCEV) models simultaneously estimate the discrete and continuous components of the choices. The dependent variable in the model is the weekly frequency of choosing each mode for commute and discretionary activities reported separately by the respondents. The dependent variable is hence a multiple discrete-continuous (MDC) variable with two components: discrete mode choice and continuous mode-specific weekly trip frequencies, mode choices of travelers are influenced by three categories of factors: characteristics of users, characteristics of the journey, and features of the transport facility (Bhaduri et al., 2020). A logistic study (Anwari et al., 2021) analyzed two logistic regression models before and during a pandemic to assess the most used modes for various trip purposes. The dependent variable in the model was the frequently used mode of transportation before and during COVID-19, with the independent variables being the frequently used modes for activities. Sankey diagrams are utilized to analyze changes in travel behavior between two categories before and during COVID-19. The quantitative information between numerous processes can be considered using a Sankey chart. When data is evaluated, the results show that long-distance recreation and greengrocery excursions had the most significant impact on mode choice before the pandemic. Work and medical trips had the most significant impact during pandemics. Long-distance journeys have

declined in importance, but business trips and greengrocery have risen, indicating a growing preference for essential travel. On the contrary, (Anwari et al., 2021) pointed out that market and long-distance recreation trips have become less critical, which may be considered non-essential travel.

Methodology

The proposed study used a questionnaire with appropriate options in which respondents are asked to make a choice from several alternatives include socioeconomic characteristics like income, education, age, and other demographical variables since different demographical groups suffered differently from the COVID-19, so demographical variables can be related to the changes in the frequency of use of transportation modes for each activity, the changes, and frequencies in the use of transportation mode and changes in travel behavior before and during COVID-19, questions about users' opinions regarding the future of mobility and the impact of digital transformation of life including remotely work, education and e-shopping, The COVID-19 changes the passengers behavior and attitude, for the benefit of other modes, that's why it is essential to evaluate the effectiveness of restrictions rate used on the transportation modes to control the spread COVID-19 this is beyond the existence of latent variables, such as perceived and unperceived behaviors that govern people's attitudes. Figures below show users' questionnaire variables that compare two stages by studying all types of transportation modes, public, private, motorized, and no motorized modes, and the mobility activities such as work/ studies activities, free time, social and shopping mobility. The variables concerning COVID-19 will be the core of the work, so it is essential to assess the elements that affect the behavior of travelers, not just in choosing the mode but also the activity size, and frequency of each trip (Fornell, C., & Larcker, 2016) (Muthen & Asparouhov, 2013)

Analysis

- Comparison of the Change in the frequencies in each category, Data conversion/ transformations. Generate a new variable 'change in frequency' as the difference between frequency (i) before and (ii) during COVID-19 and (iii) change in frequency.

Assessing the measurement model through Confirmatory Factor analysis and other psychometric properties for attitude.
- Structural equation modeling to assess the causal relationships.

The Change in frequency of the use of mode A for activity X or the opposite

The COVID-19 shows different effects on different transport modes and activities. Implementation - analysis: A comparison of the Change on the frequencies in each category, see Figure 2.

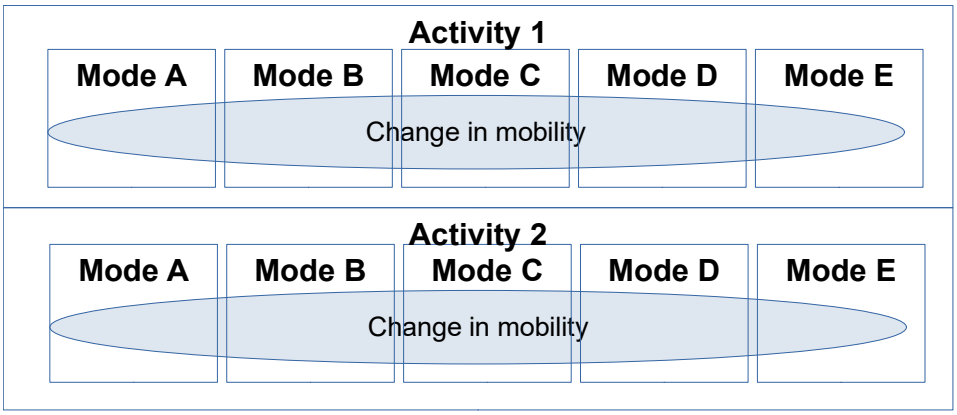

Figure 2: The Change in frequency of the use of modes and activities.

The Perceived Effectiveness of Applied Restrictions

The perceived effectiveness of applied restrictions, define the Change in the user's frequency of transport modes, moderate the attitude's effect on Change in using transportation modes bus, taxi, tram. Metro, no motorized modes, private cars, etc. The perceived effectiveness of applied restrictions, define the Change in the user's frequency of transport activities, moderate the attitude's effect on Change in using transportation activities, work, study, shopping, etc. Implementation - analysis: - Assessing of measurement model through Confirmatory Factor analysis and other psychometric properties, at least for Attitude; Structural equation modeling to assess the causal relationships, see Figure 3.

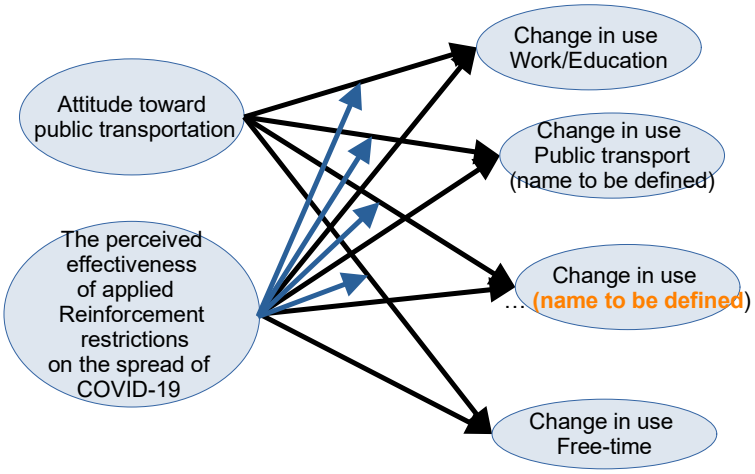

Figure 3: The perceived effectiveness of applied restrictions on modes and activities

Attitude toward Public Transportation

The perception of the enforcement restrictions (as perceived by transportation users) influences the spread of COVID-19. Implementation - analysis: Regression, or Structural Equation Model, see Figure 4.

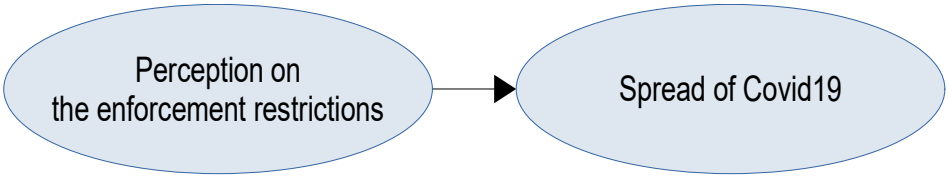

Figure 4: The perception of the enforcement restrictions influences the spread of COVID-19.

Recommendations

- In each step, a complementary analysis, risk assessment, and evaluation to assess the influence of all factors, including the attitude and satisfaction toward mobility and public transportation, perceptions on the future of mobility, and perceptions on the reinforcement acts on such changes.
- In addition, do not forget the positive experience related to the effect of COVID-19 on the environment during the lockdown. This should force the policymaker to take several actions and support other options rather than fossil fuel to reduce the negative environmental impacts.

- the change to smooth flexible peak hours to reduce congestion and maintain less crowded infrastructure and roads.
- urban land density should be reduced through better land-use management and facilitate and encourage remote and online works and activities, particularly for unnecessary trips and activities.
- Only widely shared organizations and institutions (companies, schools, industrial plants, etc.) could better address people's mobility and not lose confidence in communicating and public transport; this would have another important side-effect, allowing to decrease congestion and pollutant emissions.
- Creating a sense of community, spurring a conscience of the effects of mobility, targeted efficient use of intelligent mobility, systems, means, and intelligent tools.

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