Interdisciplinary Description of Complex Systems 21(4), 365-374, 2023

ASSESSMENT OF THE IMPACT OF THE COVID-19 CRISIS ON TRANSPORTATION AND MOBILITY – ANALYSIS OF APPLIED RESTRICTIONS

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DOI: 10.7906/indecs.21.4.6
Regular article

Received: 22 September 2022.
Accepted: 24 July 2023.

ABSTRACT

The COVID-19 pandemic has imposed radical transformations in many areas and caused a negative impact on the transportation sector and mobility activities due to the successive waves of mutated coronavirus strains. The study proposed an assessment of the impact of the pandemic on passengers' use of different transport modes and travel activities by conducting a survey in two capitals, Budapest – Hungary, and Amman – Jordan, based on the frequency of usage of mobility services before and during COVID-19, associated with various socio-economic and demographical characteristics. The SPSS software v.26 and Structural Equation Models, SEM were used for analysing and emphasizing the hypotheses. Investigations show a significant shift in transport modes and travel activities with the applied travel restrictions, while mobility patterns are directly correlated with the spread of the COVID-19 virus.

KEY WORDS

COVID-19 pandemic, mobility activities, travel restrictions, non-motorized modes, motorized modes

CLASSIFICATION

ACM: 10010405, 10010481, 10010485

JEL: R49

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INTRODUCTION

The research will focus on the impact of the COVID-19 pandemic on mobility and transportation and whether the procedures and forced restrictions that have been applied at that time were efficient and worked effectively to prevent the spread of the disease. Mobility and movement are essential for sustaining life and achieving economic, social and environmental integration. Unfortunately, the errors that occurred during the waves of the COVID-19 pandemic paralysed life in several respects causing negative impacts. Therefore, researchers should cooperate to conduct a comprehensive plan that – by including all necessary dimensions, by assessing the risks and consequences of COVID-19, and by taking into account all threats and obstacles that occured - will – be the basis for other comprehensive strategic sustainable plans in the future. It is a fact that even if we have begun to recover from this crisis and the disease has been contained to some degree, this does not mean that the dangers disappeared or the threats will not return in one way or another. It was necessary to study the impact of the pandemic from the users' point of view and their satisfaction in light of the applicable preventive measures and instructions, as well as to measure the impact on the sustainability of the transport sector, in addition to anticipating the future of digital transformation from the users' perspective. The seriousness of the pandemic compared to others meant that it was not confined to a certain region to be quarantined and contained as its predecessors. Unfortunately, the disease developed itself so that vaccines did not constitute complete protection, and the fact that some people disregarded safety measures, whether when using modes of transportation or in other places, led to disasters. Governments can achieve sustainability if they maintain sustainable transportation balances. A sustainable transportation system is defined as "one in which (a) current social and economic transportation needs are met in an environmentally conscious manner while (b) future generations' ability to meet their own needs is not jeopardized". However, the public transport system will not be successful unless it satisfies passengers, as it is essential to increase the use of public transport at a regional level, it is essential to stop reducing the number of public transport service routes to decrease travel times, cover more comprehensive areas, and improve service quality to ensure customer satisfaction [1]. Challenges regarding transportation infrastructure planning are connected with development, including current issues such as the debate on how to achieve "transport sustainability" [2, 3] or "sustainable mobility" [4]. The evaluation intelligent mobility model consists of four indicators to measure and assess the sustainability of the system these are: Efficiency, Technology integration, Traffic congestion, and Accessibility rate. If they do not work as they should, a major delay will be caused spreading all over the day. As it continues to rush hours, a smart system should be applied to solve this problem by providing accurate data and convenient information and suggesting suitable directions all along the road until arriving at the destination [5]. The systems should include a combination of ICT and AI that help people navigate other smart public transport services; so when it works effectively and efficiently, it will serve as the backbone [6].

LITERATURE REVIEW

Since mobility played a major role in the spread of COVID-19 disease, most countries applied restrictions for commuters within transport modes to control the spread as much as possible. During the COVID-19 pandemic some choose to use public transport for long-distance trips, while others have entirely shifted to other motorized or non-motorized modes. In many cities hygiene, cleanliness, temperatures checking, safe social distancing, masks, and gloves were mandatory, or at least masks were made compulsory [7]. For this and for other reasons passengers tried to shift to modes that are less congested or avoid travelling during peak hours as much as they can. In some developed countries, innovative technology, AI, and mobile applications for checking were used; Beijing allows access just through appointment to prevent crowding, Singaporeans used a Bluetooth signal between devices to prevent close distancing and to avoid connecting with infected people, some countries urged people to download an application to mobiles and smart devices that contain demographic data not just for transport access but also in any public places and buildings [8]. Many attempts to study the current situation in the presence of COVID-19, and because the transportation system has a wide flexibility and can be evaluated and assessed for any risk with a comprehensive performance to reach an optimal solutions [9], and to search for the practical means of application for the benefit of the transportation sector by evaluating the current situation, making simulations similar to reality and studying the modes and activities before and during the pandemic. Several observations, qualitative and quantitate studies found that to make a comparison between before and during the COVID-19 pandemic the suitable scenario is to measure the frequency of use [10]. Many researchers conducted interesting studies to assess the various transportation risk management, for example, but not limited to, some studies that assessed the air transport combined with risk management [11], while other studies assessed only roads transport [12]. COVID-19 and other global illnesses have a massive influence on tourism, transportation, economics, and energy demand [13]. Therefore, an efficient transportation system should be linked to enhance sanitary conditions and ventilation in public transit and lowering the risk of the pandemic [14]. According to the findings of the study, hazard increases primarily in public transportation because it is a shared environment. However, some public spaces are much worse than public transport due to CO2 concentration, so it is a matter of design and operation that is always connected with efficiency regardless of the place or period of exposure. How to maintain passenger safety in public transport, whereas companies suffer financially? This is a balanced equation that should be achieved, it is the responsibility of the companies, the stakeholders, and transport sectors to assess the risk management tools and to conduct the essential cost-effective analysis, such assessment will make the mobility system more effective, because public transit sector caused enormous socioeconomic and environmental problems that can be avoided [15]. To explore the impacts of COVID-19 on people movements, some interviews were made with young adults in Melbourne and Victoria, Australia. The study indicates that there are considerable effects on short-distance travel by all young people, but for long-distance travel, consequences are dependent on how they are progressing through critical life stages, because the pandemic had a negligible impact on some respondents, while it had a more significant impact on others, due to the acceleration in life which coincided with the presence of the COVID-19 crisis [16]. A travel survey questionnaire was used to perceive passenger satisfaction during several types of daily trips; based on a survey in New Delhi. The critical variables that were found significant on commuters' trip satisfaction and were taken into consideration include some demographic characteristics, such as gender, age, security, comfort, etc. The trip-satisfaction data are perfectly represented by logistic regression models using trip satisfaction modelling [17].

Countries took a different path when dealing with the pandemic; some countries, such as China, Spain, and Italy, applied lockdowns in some stages to control the disease, and others used what is called intelligent lockdowns such as Netherlands, Japan, and Turkey and asked the citizens not to move and stay home as much as they can. Other crucial notes during the pandemic were the positive environmental impact due to the reduction in vehicle usage, because of online learning and working, as well as people decreased their shopping, free time and social trips to the minimum and concentrated on essential trips. This significant reduction was the dominant feature in many countries, for example in the early stages of the pandemic, in Australian cities, car use decreased by 35 % compared to the pre-COVID-19 period [18]. Other cities experienced a huge reduction: more than 80 % in Milan, Rome, Barcelona, Madrid, Paris and around 70 % in Moscow, New York, London, Boston, Lisbon in car traffic in March 2020 [19].Threats in using public transport should make planners seriously think of solutions using modern technology to develop smartphone applications to use for choosing the suitable mode of transportation, suitable activity, or suitable areas during the day, while they should also try to shift toward more sustainable urban mobility by encouraging walking and cycling as much as possible by implementing certain services with suitable infrastructure and facilities [20].

METHODOLOGY

The study consists of a questionnaire survey that intended to use the necessary tools to make a comparison between two capitals: Budapest in Hungary and Amman in Jordan. The questions are defined by the frequency of usage with several multiple-choice answers assessing the passenger' perception for mobility, before and during the COVID-19 pandemic. Figure 1 shows the outdoor activities vs. transportation modes.

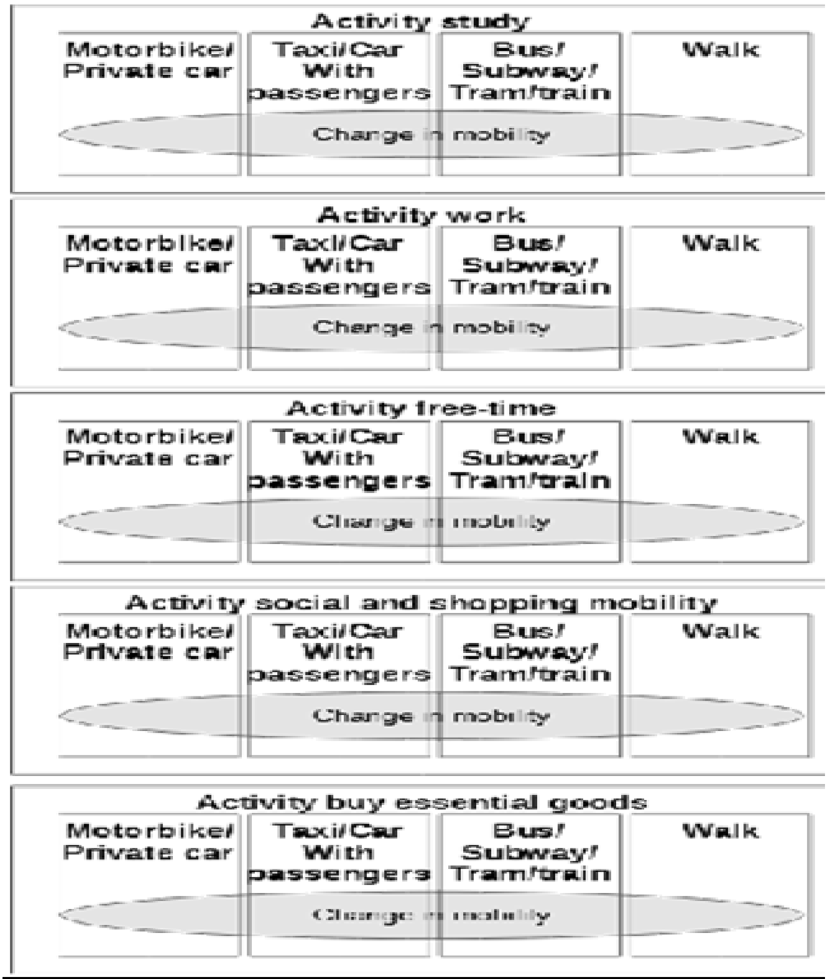

Figure 1. Outdoor activities vs. transportation modes.

The study summarizes the hypotheses as follows:

Hypothesis H_1 assesses the frequencies of usage of each transport mode the participants have been asked about; how often they use each transport mode before and during the pandemic for different outdoor activities [21, 22].

Hypothesis H_2 studies the effectiveness of the restrictions and procedures applied to prevent catching COVID-19 while using transport modes.

PRIMARY STATISTICAL ANALYSIS

Viewing the outcomes, which aimed to assess the impact of COVID-19 on users of road transport before and during the pandemic by testing the variables and items with statistical analysis using Microsoft Excel, statistical programs SPSS v. 26 [23] and AMOS [24].The major descriptive and analysis plan concentrated on the frequency of usage as a matrix, where several multiple-choice questions were asked simultaneously in a grid format. The Pearson Coefficient for validity and Cronbach's Alpha for reliability were helpful and worthy at significant level ($\alpha = 0{,}05$), the mean, standard deviance, variance, skewness and kurtosis [25] were generated to make the necessary comparison.

TEST OF NORMALITY

HYPOTHESIS H_1

Normality for before and during the COVID-19 pandemic is checked [26] through the Kolmogorov-Smirnov test [27].At the level of significance ($\alpha \geq 0{,}05$), the kurtosis and skew values were also checked to ensure the acceptable ranges (–10, +10) and (–3, +3), respectively [28], for both Amman and Budapest. The reults shows that the distribution for the first hypothesis is not normal for all variables (gender, educational level, age, occupation and income) for the items related to the frequent use of different modes of transportation as shown in Figure 2.

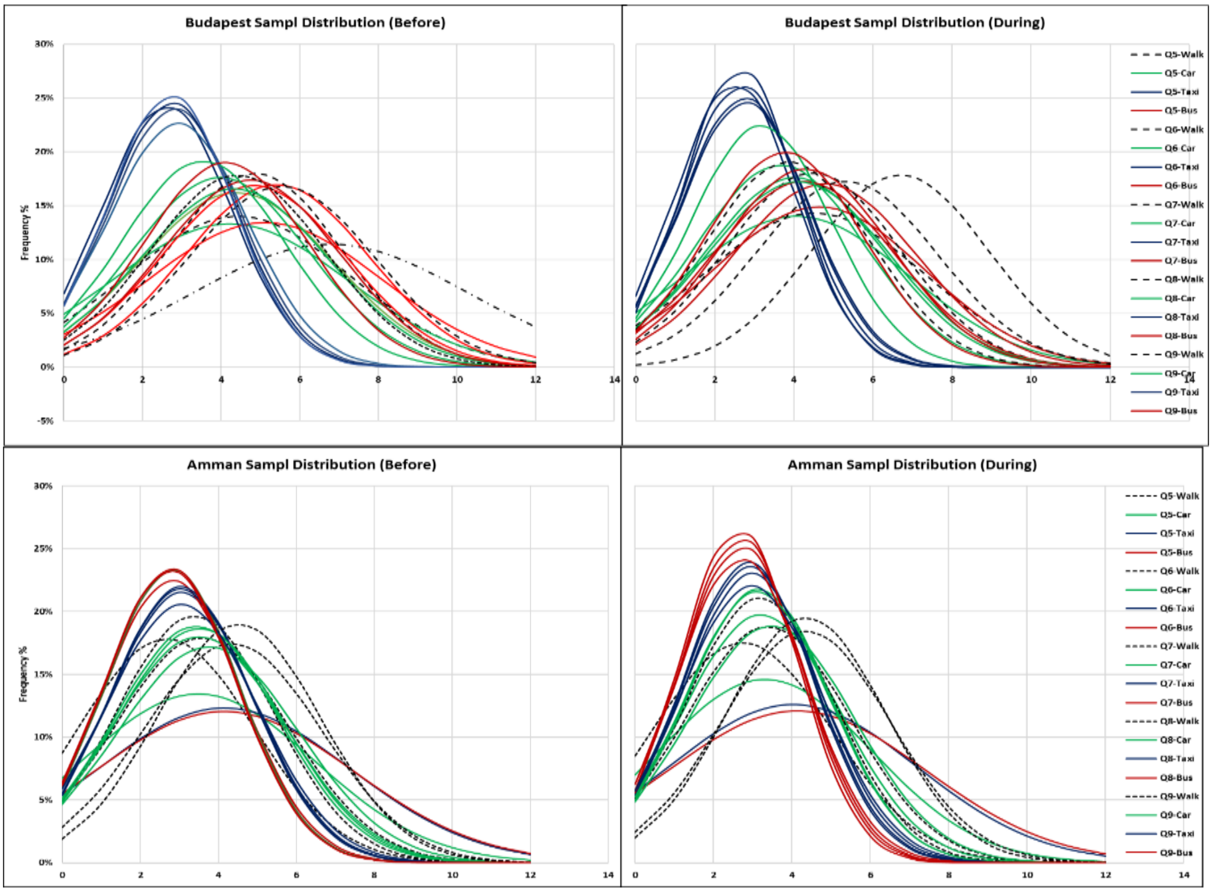

Figure 2. Distribution test for Budapest and Amman.

HYPOTHESIS H_2

Amman shows that the distribution of the Kolmogorov-Smirnov test for most variables (educational level, occupation and income) was more than the level of significance ($\alpha = 0{,}05$), This indicates that the distribution is normal for these variables. While for Budapest, the distribution of the Kolmogorov-Smirnov test is statistically significant for the variable (age, education, and income) and the distribution is not normal, while the statistical significance values for the variable (gender) indicates that the distribution is normal for this variable. In addition, the tests confirm that the values of kurtosis and skewness are acceptable for all variables and located within the ranges (–10, +10) and (–3, +3), respectively.

SECONDARY STATISTICAL ANALYSIS

Such tests include Homogeneity, the purpose is to test if the variances of groups are equal. If such an assumption is violated, a statistical adjustment needs to be done. It is assessed by using the Levene's test for equality of variances and the Scheffé statistical test [29]. The test of Multicollinearity measures the correlation between variables and logistic regression. Multicollinearity means that there should be no interaction between the independent variables [30]. The Variance Inflation Factor (VIF) values should be measured less than three to guarantee the independency between variables [31]. The test of Reliability [32], Cronbach's Alpha [33] is used since it measures the internal consistency, that is, how closely related a set of an acceptable level of reliability is. The higher the value, the greater is the stability of the value. For the questionnaire it was greater than 0,8 which is considered a very good level of stability. However to check the independent variables and their interaction i.e. how they act with each other, the ANOVA test was used under the conditions of normality distribution and homogeneity with values less than the level of statistical significance ($\alpha = 0,05$) [34]. Although such tests explain the significant of the hypothesis, it does not specify which variable or variables have the greatest impact. On the other hand, validity is a measurement of the correlation between variables, degree and direction of the relationships. The Pearson Coefficient [35] is used to generate a correlation matrix for all items of the hypothesis. It found significant at 0,01 level (2-tailed), which means that the phrases of hypothesis, are understandable and clear to the participants. Exploratory Factor Analysis (EFA) [36], and Confirmatory Factor Analysis (CFA) were conducted for identifying and explaining the relationship between variables by categorizing them based on specific linkages and to discover the underlying factors by computing the factor scores to represent the items as groups. A very important analysis is the Kaiser-Meyer-Olkin (KMO) and Bartlett's test of Sphericity [37]. The test measures sampling adequacy for each variable in the model, see Tables 1 and 2. CFA used to confirm the relationship between variables by testing the hypotheses, then to ensure that the hypotheses' variables fit as model/ models. However, it should be mention at this stage that sometimes we cannot assume the groups are indeed totally independent, because under the influence of several variables the users can easily move from one mode to another [38, 39]. CFA allows for the assessment fit for the model that specifies the hypothesized causal relations between latent factors and their indicator [40].

STRUCTURAL EQUATION MODELS SEM

Utilizing SPSS and AMOS to reach the final model, Confirmatory Factor Analysis CFA to investigate whether the results based on EFA as the initial model need to be modified, by checking the goodness of fit. Also the indeces should be taken into consideration when applying the Structural Equation Models SEM [41]. The significance and acceptance are determined by Chi-squared goodness of fit test, normed Chi-squared test, Chi-squared Ratio, Goodness of fit index (GFI), Adjusted goodness of fit index (AGFI), Normed fit index (NFI), Tucker-Lewis Index (TLI). The Comparative fit index (CFI) is between 0,9 and 1,0 and Root mean square error of approximation (RMSEA) less than 0,08 [42].

Table 1. Amman EFA before COVID-19, during COVID-19 and the change between them [37].

	KMO and Bartlett's Test		
Before COVID-19	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,891
	Bartlett's Test of Sphericity	Approx. Chi-Square	15473,935
		Df	1431
		Sig.	0,000
During COVID-19	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,894
	Bartlett's Test of Sphericity	Approx. Chi-Square	15577,402
		Df	1431
		Sig.	0,000
Change *(Before – During COVID-19)*	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,718
	Bartlett's Test of Sphericity	Approx. Chi-Square	1436,029
		Df	190
		Sig.	< 0,001

Table 2. Budapest EFA before COVID-19, during COVID-19 and the change between them [37].

	KMO and Bartlett's Test		
Before COVID-19	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,875
	Bartlett's Test of Sphericity	Approx. Chi-Square	12276,555
		Df	1431
		Sig.	0,000
During COVID-19	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,877
	Bartlett's Test of Sphericity	Approx. Chi-Square	12268,974
		Df	1431
		Sig.	0,000
Change *(Before – During COVID-19)*	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,874
	Bartlett's Test of Sphericity	Approx. Chi-Square	2300,692
		Df	190
		Sig.	0,000

After computing the measurement models and utilizing the fit statistics tests, the results show that the best fit models for Amman and Budapest are significant for the hypotheses H_1 and H_2 i.e., identify the relationship between COVID-19 and the transport mode, as well as the correlation between the change in mobility for the same activities between (before and during) and the probability of catching the disease while using the different transport modes. Both hypotheses are statistically significant. By obtaining the p-value (probability) of less than 0,05 which is acceptance, the findings revealed that the moderate degree of infection or catching the disease is the core factor influencing the respondents in deciding movements and mobility. Thus, hypotheses H_1 and H_2 have supported the assumptions, and the results improved significantly by utilizing both hypotheses together to represent the structural model.

CONCLUSION

The statistical analysis revealed that, in most cases, there are statistically significant differences between variables, which fulfils the requirements for Homogeneity and Multicollinearity.

The reliability and validity results are acceptable since they are at statistical threshold rates, even though there are apparent differences in the values of reliability between Amman and Budapest. This can be clearly and logically justified based on the fact that primary modes of transportation in Amman relies on private vehicles and taxis, while in Budapest it is basically trams, motors and buses.

The findings from the descriptive analysis corresponding with activities and mobility showed that the non-motorized modes such as walking and bike riding increased during the pandemic. Concerning the second hypothesis, comparing the mean for how the respondents would rate the probability of catching COVID-19 while using transport modes such as buses, trams, and the metro showed the highest values. They were ranked as high to extremely high probability to catch the disease. Chi-Square tests and the degree of freedom showed good EFA formulas, and this explains why CFA was used to assess the model's fitness. Both findings supported the critical factors that must be considered and incorporated for a transportation study to be comprehensive.

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