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The influence of COVID-19 on the societal mobility of urban spaces

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ABSTRACT

The previous literature in relation to the ongoing pandemic has revealed that COVID-19 may have a negative impact on social mobility and interactions within public urban spaces. While the present study has substantiated that there was no significant difference between people’s use of urban spaces before and after the onset of COVID-19. Meanwhile, after the call off of the lockdown, people have shown a very strong desire for social interactions in sociable locations. This fact has revealed the novelty of present study. However, the pedestrians’ propensity for commercial spaces has mitigated in comparison with the pre-COVID-19 periods; which is in line with previous studies.

Since February 22nd, 2020, the Iranian Ministry of Health has officially announced the prevalence of the coronavirus pandemic and consequently, all public, recreational, cultural and educational spaces were closed down. Over than three months later, on June 6th, as the situation became relatively under control, the reopening of public spaces, especially universities was announced, and commuting was permitted in essential cases. But shortly after the announcement of the lifting of restrictions, a surprisingly growing trend was observed regarding travels, so that the rate of pedestrian traffic had been unprecedented in some cases leading to the emergence of the second wave of the pandemic throughout this country, and some provinces experienced a red situation again. Therefore, considering the fact that one of the strategies of the World Health Organization (WHO) is to prevent the close contacts of people in urban areas, and on the other hand, people’s inattention to these strategies has led to more serious problems, this study seeks to investigate whether or not COVID-19 delivers significant impacts on the societal mobility of urban spaces.

This study is based on a comparison of the statistical data obtained before and after the advent of COVID-19 within the Rasht Municipality Square, located in northern Iran. The concept of societal mobility can be defined as the ability to move and interact freely and easily among people. Therefore, gate count and movement tracing methods have been used regarding the field observations of pedestrian’s mobility, and its adaptation to the simulation tests were obtained through syntactical analysis. Also, in order to identify activities, the static snapshot technique was implemented in order to perceive people’s behavioral patterns aimed at measuring their possible behavioral transformation. Hence, the ArcGIS and Depthmap software were also used to take advantage of land use within the studied area in order to accommodate the uses with the location of the investigated behaviors taking place there. Accordingly, the research findings were discussed and compared with each other using the independent sample t-test in order to determine the relationship between the findings and obtain the optimum response to the research objective.

The findings of the gate count method are presented to illustrate the density and frequency of mobility patterns in the Rasht Municipality Square. In selecting the gates, it was attempted to identify the index points of the study area in terms of recreational, cultural, social and economic potentials, and subsequently make a comparison between the periods before and after the outbreak of COVID-19 (Fig. 1). It should be noted that each gate was carefully examined for 5 min, and the number of people who crossed the hypothetical axis of the gates during that time was recorded. For better reliability, observations were made on the predetermined weekday and weekend.

The findings from the frequency of pedestrians in the ten gates investigated during the weekday indicated that in the period before the COVID-19 outbreak, gates 4 and 5 had the highest pedestrian traffic with 913 and 884 crossings in five minutes. These figures are followed by gates 7 and 9 with 792 and 771 crossings in the next positions respectively. Whereas gates 1 and 6 (with frequency levels of 275 and 436 crossings) have the lowest traffic in the pedestrian area. On the other hand, the findings of the gate count method in the post-COVID-19 period...
indicated that gates 4 and 7 had the highest density of pedestrians with 1012 and 702 crossings respectively. This is followed by gates 5, 9 and 2 with densities of 622, 617 and 616 crossings respectively, while gates 1, 8 and 6 (with the density of 323, 440, and 443 crossings) had the lowest density of pedestrians (Fig. 2).

In general, there were considerable differences between the observations made before and after the outbreak of the COVID-19 pandemic with regard to the gate count method. Among these remarkable differences, gate 4 can be mentioned with a significant increase in the number of visitors in this area. There was also a significant difference regarding gates 5, 8 and 10, which suggested a significant decrement in the number of visitors in these areas. Also, there was no significant difference in the density of crossings at gates 1, 2, and 3, and the statistics was relatively constant (Fig. 2). The results indicated that the pedestrians' mobility towards sociable spaces had augmented in comparison to pre-COVID-19 periods. On the other hand, the pedestrians' propensity for commercial spaces has mitigated in comparison with the pre-COVID-19 periods.

In order to complete the analysis process in this section, the findings obtained from the field observations were compared using the SPSS software and the independent sample t-test. The results of the analysis obtained from Levene's test for equality of variances in the gate count method indicate that on the weekday under study, the P-value is 0.455, and since it is greater than 0.05, this indicates that the variances of the two data are equal and homogeneous. Also, the value of 2-tailed significance is equal to 0.491, which indicates that the mean of the groups is statistically equal to each other, and there is no significant difference between the obtained data. Therefore, based on the statistical calculation of the independent sample t-test, no significant difference is observed in the obtained findings regarding the mobility of pedestrian flow in Rasht Municipality Square.

In the next phase, the three main junctions in the study area were observed empirically in order to assess the movement trace technique at the two intervals before and after the outbreak of COVID-19. Previous studies have shown that the Isovist and Visibility Graph Analysis (VGA), which represent the visual capability of individuals from a certain point, have a significant correlation with the selection of the desired path. Therefore, in this analysis, in addition to comparing the data from different periods, it will be possible to compare them with the visual analysis of the simulation tests. In case of any discrepancies in the findings, the reasons will be further discussed. Thus, based on the spatial configuration analysis, spaces that are simulated with cold colors are...
less likely to be chosen by passers-by, and consequently, warm colors initiate more interest in passers-by to enter those spaces (Askarizad & Safari, 2020). Findings from VGA and Isovist indicated that at junction number one, the highest visual field of view was in the B direction. While at junction number two, despite having the highest Isovist field of view towards B, VGA findings indicated more visibility potential towards A. Also at junction number three, the findings of VGA and Isovist indicated higher visibility in B (Table 1, Fig. 3).

Findings from the observations of the movement trace method in the period before the COVID-19 outbreak indicated that junction number one had the highest number of visitors (61%) to route B, which is also in line with the simulation findings. But at junction number two, the highest number of visitors (52%) were going straight, which contradicts with the findings of the VGA, but is in line with the Isovist test. Also, at junction number three, the highest choice of path was towards path C with 42%, which was again in contradiction with the findings of the simulation test (Table 1, Figs. 3, 4A). On the other hand, the results obtained from the movement trace technique indicated that

| Analysis | Junction no. 1 | Junction no. 2 | Junction no. 3 |
|----------|---------------|---------------|---------------|
| VGA      |               |               |               |
| Isovist  |               |               |               |

Fig. 3. The level of selected desired routes (A, B, C) according to the visibility graph analysis (VGA) at the three identified junctions in the studied area.

Fig. 4. (A) Comparison of the selected routes at each intersection before the widespread outbreak of COVID-19; (B) Comparison of the selected routes at each intersection after the widespread COVID-19 outbreak.
approximately four months after the outbreak of COVID-19, with 67%, route B still had the highest rate of use out of the three existing routes at junction number one. While, at junction number two, route A had the most visitors with 46%, which was in line with the findings of the VGA and Isovist tests. Also, at junction number three, most of the movement patterns were towards path B, which this time indicated that the findings were consistent with the simulation test, and contradicted the observations made before the outbreak of COVID-19 (Fig. 4B).

Further investigations regarding the reasons behind some of the existing contradictions in the simulation tests, and empirical observations before the outbreak of COVID-19 highlight significant issues. The reason of contradiction can be justified due to the existence of commercial land uses, which consequently motivates people to choose that particular route over others. In fact, in junctions 2 and 3, the majority of people display a certain tendency towards the route leading to the Rasht Grand Bazaar (RGB) that houses most of the commercial land uses. This may reveal the importance of some specific land uses that have a significant priority for the citizens. This trend is not in line with the urban morphological analysis and consequently, the spaces that are located in proximity to RGB have a poor level of integration and VGA values, despite their importance in terms of pedestrians’ mobility. Meanwhile, the data obtained during the period after the outbreak of COVID-19 have faced conspicuous transformations. In this way, in junctions 2 and 3, peoples’ movement patterns towards commercial uses have declined considerably so that people have not shown any specific tendency to use such spaces as they did before. The findings shed light on the relatively higher impact of the pandemic on markets, which is aligned with many other findings throughout the world (Sharifi & Khavarian-Garmsir, 2020).

In the next step, the behavioral patterns of people within the urban environment were captured using the static snapshot technique. In this regard, to better comprehend the cognitive maps, the study area was initially divided into five different zones according to the land use around the area. Therefore, cultural, social, commercial, socio-economic and socio-cultural zones have been identified based on the GIS maps (Fig. 5B). On the other hand, to evaluate the behavioral patterns of
people, four types of common behaviors in the study area, including walking, talking, sitting and standing, were scrutinized, and these behaviors were instantly recorded within the built environment by means of taking snapshots (Fig. 5).

Findings from the field observations using the snapshot technique indicated that there are significant differences in some of the identified zones before and after the onset of COVID-19. In zone 1, which is generally known and regarded as a cultural zone, there was a relative increase in the number of visitors, followed by zone 2 and zone 3 during the post-COVID-19 period. Whereas in zone 4, which leads to the RGB, the number of visitors has dramatically dropped by 38 in the post-COVID-19 period. Following this fluctuating trend in zone 5, the number of people has increased again in the post-COVID-19 period, so that this rate has increased by 16 people, while in zones 6 and 7, the number of people was sharply reduced again. Overall, in zones 1, 2, 3, and 5, the range of observed people has increased after the COVID-19 outbreak. Meanwhile, this range has diminished in zones 4, 6, and 7 (Fig. 5A).

Also, the results of people’s behavioral patterns in urban spaces during both periods revealed that the most common behaviors were walking, talking, sitting and standing, respectively. Accordingly, the test of observations in the pre-COVID-19 period indicated that the highest rate of walking was in zone 6. While this fact held true for zone 5 during the post-COVID-19 period and subsequently for zone 2. In relation to the category of talking and sitting, in the pre-COVID-19 period, the highest rate was related to zone 3; but with the difference that this amount has increased significantly so that the highest concentration of social behaviors has taken place within this zone. Regarding the standing behavior pattern, in almost all zones, the behaviors were relatively constant and did not change significantly (Fig. 6). Indeed, people may have bounced back in the walking and social interactions, but the markets have remained stagnant.

Relevant literature has validated that human mobility patterns have undergone conspicuous transformations during this pandemic (Pal et al., 2021) and mitigation of unnecessary human mobility can help bring COVID-19 under control (Shen, 2021). Whereas studies in China have revealed that the impact of the lockdown was more effective than the mitigation of population mobility in controlling COVID-19 (Wei et al., 2020). This may demonstrate the different attitudes of people in different cross-cultural societies. Meanwhile, a set of studies were conducted to measure urban mobility during lockdown periods in Italy (Beria & Lunkar, 2021), whereas this research presents a comparative study of societal mobility before and after the lockdown periods.

In general, the previous research literature tends to believe that COVID-19 may have a negative impact on social interactions and mobility within public urban spaces. The present study substantiates that after the end of the lockdown, people have indicated a very strong desire for societal mobility in sociable places, which reveals the originality of the current study. However, the pedestrians’ propensity for commercial spaces has mitigated, which is in line with previous studies. Thus, it can be concluded that due to the social nature of the human beings, lack of attention to these fundamental requirements may lead to breaking social distancing regulations. This reveals the reason behind people’s inattention to the strategies of the WHO and subsequently, the increment trend of COVID-19 in the society. All in all, in addition to the direct impact of the pandemic on public health, lockdowns may have a manifest efficacy on the social requirements of the people. This fact necessitates paying particular attention to the implication of adopted strategies by planners and legislators within built environments. Regarding further research suggestions, the interaction of social distancing, and social interactions in post-pandemic urban design can be taken into account.

CRediT authorship contribution statement

Reza Askarizad: Conceptualization, Formal analysis, Investigation, Project administration, Resources, Methodology, Software, Visualization, Writing - original draft. Jinliao HE: Data curation, Project administration, Supervision, Validation. Setareh Jafari: Resources, Investigation, Software, Visualization.

Declaration of competing interest

The correspondence author declares that there is no conflict of interest to the publication of this manuscript.

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