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Extent to which COVID-19 will affect future use of the train in Israel

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\textbf{ABSTRACT}

Many countries have taken a variety of measures to stop the spread of SARS-CoV-2, the coronavirus responsible for COVID-19 infections. Among the most important of these involve using social distancing to prevent contact. Restricted social contacts have important effects on activity participation and on travel demand. The current study examined an array of less-studied factors, such as attitudes and beliefs toward train use, including risk perception of flu-type infection, alongside more traditional factors, which together affect decisions whether to continue using the train. Data was collected using an internet survey application. The study was based on two surveys that were conducted approximately seven months apart, the first completed by 237 participants and the second by 149. We developed a structural equation model to better understand the influence of various factors on decisions whether to continue to use the train. We found a correlation between perception of the risk of infection and the decision to continue train travel. Study results also demonstrate the relation between trip purpose and the decision to use public transportation. The study results highlight the importance of many attributes favorably associated with train travel, including saving time, reliability, and comfort. Therefore, in contrast to the existing situation where the railway company makes its own decisions to decrease trip frequencies and to cancel some lines, government policy makers and the railway company should maintain a strong frequency schedule and increase the number of lines in order to accommodate social distancing. In addition, we found that the most effective measures for encouraging people to keep traveling by train required mask use, preventing people with flu-like symptoms from traveling by train, and fining those who do not comply.

To what extent will COVID-19 affect future travel behavior? Will people now prefer travel by private car instead of by public transportation? To what extent is the perception of infection risk going to affect decisions to continue using public transportation, especially the train?

The main objective of this study is to try to resolve these questions by examining an array of infrequently-studied factors, particularly attitudes and beliefs, alongside more traditional factors, which together affect the decision whether to continue using the train. The considered factors include the impact of risk perception of being infected by the flu in the past, and in the present, the risk of being infected with COVID-19; fatalistic beliefs; the degree of sensitivity to various PT attributes such as price, availability, on-time arrival, comfort, time-savings, and reliability; the cleanliness of the train and train station; and the

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The paper is structured as follows. Section 2 provides a summary of the current research literature about factors that affect the choice of travel mode. Section 3 describes the study’s data collection methods. Section 4 shows the evaluation results. Section 5 provides a general discussion of the study findings.

2. Literature review

Demand for public transportation is high due to rapid population growth. Trains, a major form of public transportation, hold a unique position in the transportation sector and are considered to be a key determinant of national growth in many countries (Rajeshwari & Tamilchelvi, 2014). People prefer rail transport for various reasons (Rajeshwari & Tamilchelvi, 2014). It is essential to understand the preferences and needs of the passengers in order to maintain this preference, especially when the world faces the consequences of pandemics such as the coronavirus (e.g., Jiang et al., 2020; Lipistch et al., 2020).

Many countries have taken a variety of measures to stop the spread of SARS-CoV-2, the coronavirus responsible for COVID-19. Among the most important of these involve using social distancing to prevent contact (Jiang et al., 2020; Lipistch et al., 2020). This is effective for diseases such as COVID-19 which are transmitted by respiratory droplets and require human proximity for transmission (Wilders-Michard and Freedman, 2020). Israel, in line with many other countries, has enforced social distancing by imposing lockdowns. The problem is that no one can anticipate how long social distancing measures will last, and ultimately, how massive populations will react to lockdown impositions. The world has witnessed a second wave of coronavirus, and subsequent waves might result in new waves of social distancing in the near future (Wu et al., 2020).

Restricted social contacts have important effects on activity participation (De Vos, 2020). These restrictions increase the number of unemployed people and encourage people to work from home; decreasing, as well, their willingness to participate in leisure activities. Consequently, travel demand decreases and many countries have already seen spectacular drops in car traffic along with public transportation ridership (e.g., Carrington, 2020; Goldbaum, 2020; Plumer and Popovich, 2020). The decrease in public transportation ridership often results in less frequent provision of services (De Vos, 2020). Because this is likely to be a temporary situation and an efficient treatment will presumably be found in the not-so-distant future, a return to normal life and a rise in travel demand may be expected. The concern at present is whether people will return to using public transportation or whether they will prefer using private cars out of fear of being infected by the SARS-CoV-2 coronavirus or some other disease, such as influenza.

Substantial efforts have been expended on understanding the factors that affect passenger choices with respect to a rail transport system. Many studies indicate that the preferences and needs of passengers are dynamic and differ based on many variables, including age, occupational status, and purpose of travel (Rajeshwari & Tamilchelvi, 2014; Litman, 2013; Patrunia et al., 2018). Socio-economic factors such as income, car ownership, employment, and occupation types have important influences on demand for train journeys (Patrunia et al., 2018). Patrunia et al., 2018 also found that increasing income levels are tied to an increase in the propensity to travel by train, and that found that people with driving licenses are less likely to use the train for commuting and other trips. Moreover, as the number of cars in a household increases, the propensity to travel by train decreases. The presence of a company car affects the propensity for train travel for commuting and business travel. In general, older people and those under 16 years of age are less likely to travel by train, whereas those who are employed and are under 25 years of age are more likely to make multiple commuting trips by rail.

Levels of service, comfort, reliability, and flexibility are also important factors that influence travel by train (Monami, 2000; Paulley et al., 2006; Hadiuzzaman et al., 2019a,b; Eboli and Mazzulla, 2007; Johansson et al., 2006). Gatersleben and Uzzell (2007) also suggest that public transportation is stressful due to unpredictability and longer travel times.

Rajeshwari and Tamilchelvi, 2014 found that high-end users are more sensitive to time and comfort aspects. This result is consistent with Johansson et al., 2006, who indicated that comfort preferences are correlated with the likelihood of choosing bus use over car use and train use over bus use. In addition, Hadiuzzaman (2019), and Migliore et al., 2014 examined the influence of the degree of cleanliness or lack thereof perceived by users of a public transportation system. The cost of the trip also plays an important role in the choice of a mode of travel (Cats et al., 2017).

Gatersleben and Uzzell (2007) recognized that train travel also affords passengers sources of pleasure. These include the time and space to read during the trip, to listen to music, to interact with other people, and to gaze at passing scenery. The ability to work while being transported was also found to be an important factor that influences passenger satisfaction and the choice to use the train (Ettema et al., 2012).

Several studies have examined the influence of safety and security perceptions on the choice of travel mode (see Thomas et al., 2006; Rajeshwari & Tamilchelvi, 2014; Hadiuzzaman et al., 2019a,b; Johansson et al., 2006). Elias and Shiftan (2012) analyzed the effect of various factors, such as perception of the risks of being involved in road crashes, awareness of the negative environmental effects of private transportation, knowledge of environmental problems, fatalistic beliefs, and attitudes toward various public transport features, focusing on the level of intention of individuals to shift from vehicular to public transport and to walking. The results support the hypothesis that the perception of the risk of being involved in road crashes is positively correlated with sustainable travel behavior. Concern for and knowledge of environmental problems, by contrast, exerts no significant effect on the intention to shift to PT. Relatively, the impact of fear of flying on travelers’ choices about whether to travel by air was examined by Fleischer et al., 2012).

From the literature review, it appears that only limited research has been done on the perceived risk of being infected by the flu on the choice of transportation mode. Troko et al. (2011) examined the relationship between public transport use and the acquisition of an acute respiratory infection. They found a statistically significant association between acute respiratory infection and bus or tram use in the five days before symptom onset. The risk appeared greatest among occasional bus or tram users, but this trend was not statistically significant. Gosc and Johansson (2018) found a correlation between the use of public transport and the spread of influenza-like illnesses.

In sum, little is known about the influence of the perception of risk of influenza infection on the choice of travel mode, and still less about the perception of risk of being acquiring a COVID-19 infection. The current study, consequently, is an attempt to examine the long-term impact of the perception of risk of being infected with the COVID-19 disease, then to relate that to decisions whether to continue using the train once the COVID-19 pandemic has largely passed.

3. The railway in Israel

Israel Railways is the state-owned principal railway company responsible for all inter-city, commuter, and freight rail transport in Israel. The network is centered in Israel’s densely populated coastal plain, from which lines radiate out in many directions. In 2018, Israel Railways carried 68 million passengers. There are 68 stations on the Israel Railways network, almost all of them accessible to disabled persons, with public announcement systems, passenger information systems, and vending machines; most stations have parking available.

Following the coronavirus outbreak the railway system was entirely halted on March 26, 2020, with service interruptions continuing until 22 June. Based on data from the Israel Railways Company (2020), in 2018
there were 67, 722, 240 trips, and in 2019 there were 68, 877, 340 trips. By the beginning of December 2020 the number of 2020 trips had decreased to only 21, 125, 619, less than 35% of the preceding year’s totals.

It is important to note that the return of railway services was followed by changes in train travel conditions. Entry to train stations is now subject to requiring passengers to have their temperatures taken, wear a mask, and to obey all other Ministry of Health instructions, which are published at stations and on the trains. Passengers must buy tickets online in advance. The number of passengers permitted on the train is limited to 50% of the number of seats; therefore, the number of train entry passes is limited accordingly. In addition, the trains are operating on limited schedules on many routes, with a number of lines closed.

4. Methodology

4.1. The data

Two surveys were conducted during COVID-19 travel restrictions in order to examine changes in travel behavior, especially demand for train travel during the time while the coronavirus pandemic still influenced how people got from one place to another (if they travelled at all). The first survey, administered from mid-April to mid-May 2020, had 273 participants, of whom 237 actually completed the project. The second survey, administered during the first two weeks in December 2020, had 172 participants, of whom 149 actually completed the project.

The data was collected through an internet survey sent by means of WhatsApp and other social media platforms, using a snowball method to reach other participants. The participants in the current study belong to the northern and southern areas of Israel. In addition to the train, both areas have public transportation in the form of multiple bus services, shared taxis, also called service taxis, including vans that typically seat ten passengers. They follow the general routes of the main bus lines.

The survey focused on the commuter rail services. The main commuter lines run South to North, with trains running from to Beer Sheva, in the Negev Desert, through Tel Aviv, in the center of the country, and continuing along the Mediterranean coast through Haifa to Nahariya, in the far North; branch lines from the coast eastward to Karmiel, Bet Shean, Petach Tikvah, and Jerusalem.

The survey included questions about the respondent’s socio-demographic characteristics (age, gender, marital status, work status, income range). Other questions addressed the frequency and purposes of traveling by train. Attitude-related questions were measured based on respondent answers given on a scale of 1–5, with 1 being “not at all” and 5 being “very much.” These questions sought respondent attitudes with regard to their perception of any risks of being infected by diseases such as the flu, or corona in particular, while traveling by train. Fatalistic beliefs, the degree of sensitivity to various PT attributes such as price, availability, time, comfort, time-saving, and reliability, as well as attitudes about the cleanliness of the train and train station, were also examined, along with questions about the current and long-term influence of the coronavirus on the decision to travel by train.

4.2. Analysis

We used chi-square tests for the categorical variables and a T-test to examine such differences for continuous variables; a bivariate correlation analysis was applied for categorical variables. Data was analyzed using SPSS. We also conducted a factor analysis in which 18 attitudinal statements were subjected to principal component analysis with a Varimax rotation, and used the results to identify several attitudinal variables. We then used a structural equation model (SEM) as presented by Golob (2003), to examine the influence of these variables and demographic variables on the decision to continue using the train.

4.3. The sample

Table 1 summarizes the main demographic and socio-economic characteristics of the respondents to the two surveys. Comparisons were done using a Pearson chi-square test (p = 0.001 unless stated otherwise). In both surveys about 42 percent of the participants were women. The age of about 45% of these respondents ranged from 26 to 35. About half were married, and more than half (59.3% in the first survey, 62.4% in the second) have an academic education. With regard to employment status and education level, we found a significant difference between the two surveys. In the first survey about half the participants were salaried workers and 41% were students, while in the second survey the percentage of the salaried workers was higher and the percentage of the students was lower. In both surveys more than 95% of the participants had a driving license. Income for 51.1% of the first survey participants was below the 9500 NIS national average, while 33.3% reported that their income was above average, compared to 42.9% with below average income and 28.2% with above average income in the second survey. In both surveys more than 65% of the participants have two or more cars in their household. No significant differences were found with regard to most of the demographic and socio-economic characteristics, excluding work status and income.

5. Conceptual model

Fig. 1 shows the conceptual model for our analysis. Residents make multiple inter-related choices regarding their daily travel-related activity patterns such as trip purpose, trip frequency, and trip chaining, as well as some longer-term related decisions, such as car ownership and work location. In addition, their decision to prefer using the train over a private car is also affected by the attributes of the rail services: travel time, time saved, comfort, reliability, possibility to work, and ride price.

Commuters try to maximize their utility in the choice of any travel mode, and risk perceptions affect this utility. In our case, the risk of being infected by coronavirus negatively affects the willingness to continue using the train as a travel mode. Fatalistic beliefs affect risk perception because the more fatalistic the belief the less perception of risk. Additionally, the hygiene and cleanliness levels of the train and the...
train station also affect the perception of risk. Frequency of train travel is a further factor affecting risk perception and the decision to continue using the train once the coronavirus pandemic passes; so are demographic and socio-economic characteristics. Fig. 1 gives a schematic illustration of these factors.

The conceptual model of the extent of the impact of fear of infection by coronavirus on the decision of the commuters to travel by train, described in Fig. 1, can be transformed into a SEM. The SEM enables the modelling of phenomenon by considering both the unobserved “latent” constructs and the observed indicators that describe the phenomenon.

There are two components of our SEM: the first describes the relationship between independent and dependent variable like risk perceptions and decisions to travel by train, and latent variables such as risk perception, fatalism, train attributes and hygiene, and variables, such as individuals’ demographic and socio-economic characteristics, and travel frequency. The second component describes the relationship between latent and observed variables. Equation (1) presents the basic equation of the latent variable model (Bollen, 1989). The measurement of the results of these latent processes is related to manifest endogenous variables as shown by measurement equation (2):

\[
\eta = \beta \eta + \Gamma X + \varsigma
\]  
\[
Y = \Lambda \eta + \epsilon
\]

In equations (1) and (2), \( \eta \) is a vector of latent variables; \( X \) is a vector of observed exogenous variables; \( Y \) is a vector of observed endogenous variables; \( \varsigma \) is a vector of other exogenous random variables affecting utility and attitude, but not included in the model; and \( \epsilon \) is a vector of measurement errors. Both \( \varsigma \) and \( \epsilon \) are assumed to follow an identical independent distribution across observations.

6. Results

6.1. Travel characteristics

Fig. 2 presents the frequency of traveling by train among the two surveys. While in the first survey the train system was entirely halted, in the second survey the train system is active. In first survey we asked participants about the frequency of their travel before the system was halted. Only in the second survey did we ask participant about the

![Fig. 2. Frequency of train travel.](image-url)
frequency of traveling both before and after the outbreak of the coronavirus. In the first survey about 21 percent of the participants respectively travel by train every day or almost every day; only 17 percent of the second survey participants did so. In the first survey about 47 percent only rarely travelled by train; the number of rare train travelers increased to 56 percent of the second survey participants. By applying a Pearson chi-square test no significant difference was found in the frequency distribution of train travel between the two surveys (p = 0.458) before the outbreak of the coronavirus. The second survey, however, showed a significant decrease (p = 0.000) in the frequency of traveling by train before and after the outbreak of the coronavirus. In the second survey only 6 percent of the participants indicated that they currently travelled by train every day or almost every day, in comparison to about 17 percent with similar travel patterns before.

Fig. 3 shows the main purpose of traveling by train. One can see that within the first survey, about 19 percent travel by train for work purposes and 8 percent for work-related purposes, while about 17 percent do so for studying. About one fifth of the first survey participants travel by train for leisure purposes. Similar results for the second survey participants were 28 percent, 7 percent, and 18 percent, respectively.

### 6.2. Attitudes toward the train

Table 2 presents the influence of decision variables related to the train attributes and shows, as to each survey, how they relate to the decision to travel by train rather than by private car. Employing a t-test procedure, no significant differences were found between the means of the various attitudes, excluding the price of the trip (p = 0.04). The table demonstrates that comfort and saving time, followed, to a lesser degree, by certainty of destination arrival time, are factors that greatly influence participant decisions. Participants did not assign significant importance to the price of the trip, relative to the other variables.

Table 3 demonstrates the significant differences in attitudes toward the train including the risk perception of infection by flu or by COVID-19 specifically, and positions with respect to hygiene and cleanliness in the train and train station reported by the participants in the first and second survey.

To the question “to what extent have you met people who were coughing or showing signs of the flu?” in the first survey, about 16 percent responded “much” and “very much,” compared to 20 percent in the second survey. Meanwhile, in both surveys about 9% indicated that they are “very much” afraid of catching the flu while traveling by train. Table 2 shows that in the first survey more than half (54.4%) the participants “much” and “very much” believe that traveling by train is a source of transmission of disease, while in the second survey this percentage was decreased to 43%. In connection with the previous question, in the first survey only about 8% “much” and “very much” believe that there is no danger of being infected by coronavirus while traveling by train, while the majority believe that there is such a danger; in the second survey and consistent with the previous question, more participants believe that there is no danger of being infected by coronavirus while traveling by train. We can perhaps explain these differences by the experiences that travelers by train were gaining after the return of railway services. Table 3 shows that most of the participants in both surveys were dissatisfied with the level of hygiene and cleanliness in the train and in the train station.

By applying the Pearson correlation test we found that there is a positive and statistically significant correlation between participants’ opinions and their friends’ opinions as to the danger of being infected by coronavirus while traveling by train (Pearson correlation = 0.520; p-value = 0.000). The study results show that in the first and second survey, respectively, 16.9% and 8.1% of the participants answered in the affirmative to the question seeking whether the respondent had “been infected with a flu or similar illness at least once as a result of exposure to sick people on the train while traveling?”

To see whether maintaining train use could be encouraged in the current health-related environment, we suggested many solutions to participants, hoping to elicit responses as to which might affect their decisions regarding train travel. Table 4 shows that among all the suggested solutions, there were significant increases in the percentage of the participants that strongly believe that these specific solutions encouraged continuing to use trains. The most important solution requires the use of a mask and checking traveler temperatures. Preventing people with the flu from traveling by train and imposing a fine on those who nevertheless do engage in non-compliant travel, also ranked high in the

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**Table 2**

| Decision variables | Survey category | N | Mean | S.D | Std. Error Mean |
|--------------------|----------------|---|------|-----|----------------|
| Price of the trip  | 1.00           | 237 | 2.85 | 1.411 | .092 |
|                    | 2.00           | 149 | 2.41 | 1.419 | .116 |
| Comfort            | 1.00           | 237 | 3.40 | 1.394 | .091 |
|                    | 2.00           | 149 | 3.53 | 1.505 | .123 |
| Saving time        | 1.00           | 237 | 3.43 | 1.498 | .097 |
|                    | 2.00           | 149 | 3.56 | 1.463 | .120 |
| Possibility to work| 1.00           | 237 | 2.78 | 1.428 | .093 |
|                    | 2.00           | 149 | 2.68 | 1.570 | .129 |
| Certainty of arrival time to destination | 1.00 | 237 | 3.35 | 1.455 | .094 |
|                    | 2.00           | 149 | 3.26 | 1.583 | .130 |

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**Table 3**

| Variables affecting the decision to travel by train instead of by private car. | N Mean S.D Std. Error Mean |
|---------------------------------------------------------------|---------------------------|
| Price of the trip                                             | 1.00 237 2.85 1.411 .092 |
| Comfort                                                        | 1.00 237 3.40 1.394 .091 |
| Saving time                                                    | 1.00 237 3.43 1.498 .097 |
| Possibility to work                                           | 1.00 237 2.78 1.428 .093 |
| Certainty of arrival time to destination                      | 1.00 237 3.35 1.455 .094 |
|                                                                 | 2.00 149 3.26 1.583 .130 |

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**Fig. 3.** The main purpose of the train journey.
percentage of respondents approving this solution. Another solution that found favor was to arrange passenger seating so that passengers are 2 m away from each other, for example in window and aisle seats.

6.3. Coronavirus and the decision to continue traveling by train, examined by trip purpose

Fig. 4 shows that a high percentage of the participants (45.1% and 47.0% of the first and second survey, respectively) indicated that exposure on a train to people who had coronavirus or other infectious diseases very much affected their decision whether to travel by train or by private car. No significant difference in the distribution was found between the two surveys (p = 0.458). A positive and statistically significant correlation was found, however, between the experience of having been infected by the flu or a similar illness at least once while traveling by train and the decision to travel by train (P-value = 0.034). In addition, a positive and statistically significant correlation was found between the belief that the train is a source of disease infection and the decision whether to travel by train (P-value = 0.000).

We used the surveys to examine the impact of the coronavirus pandemic on the demand for public transportation, particularly the demand to use the train in the future, after the government decides to resume full-scale passenger rail services. In the first survey the questionnaire presented three scenarios for resuming train operations. In the first scenario there is a partial return to normal life and routine while the corona outbreak continues; in the second scenario there is a complete resumption of routines while taking limited precautions when the coronavirus epidemic grows less virulent; and in the third scenario there is a full return to normal routines after the coronavirus epidemic has passed.

### Table 3
Attitudes towards the train. By using Pearson chi-square test we found.

| Position towards risks | Survey 1 |  |  |  |  | p-value |
|------------------------|----------|---|---|---|---|--------|
| While traveling by the train, to what extent have you met people who were coughing and showing signs of the flu? | 1 | 32.1 | 27.8 | 24.5 | 11.8 | 3.8 | 0.119 |
| | 2 | 22.8 | 10.9 | 28.9 | 11.4 | 8.7 | 0.108 |
| Before the corona outbreak, while traveling by the train, to what extent you were afraid of catching the flu? | 1 | 54.0 | 16.0 | 12.2 | 8.0 | 9.7 | 0.006 |
| | 2 | 6.7 | 18.1 | 32.2 | 24.8 | 18.1 | 0.001 |
| In my opinion there is no danger of being infected by coronavirus while traveling by train | 1 | 52.7 | 22.8 | 16.5 | 5.9 | 2.1 | 0.000 |
| | 2 | 37.6 | 20.8 | 24.2 | 12.1 | 5.4 | 0.022 |
| Most people who are important to me, and whose opinion I value, think that traveling by train will not lead to infection by coronavirus | 1 | 22.8 | 17.4 | 32.9 | 12.8 | 14.1 | 0.023 |
| | 2 | 10.7 | 17.4 | 39.6 | 24.2 | 8.1 | 0.045 |
| Position towards hygiene | 1 | 20.7 | 24.1 | 32.1 | 17.3 | 5.9 | 0.006 |
| | 2 | 16.0 | 24.1 | 33.8 | 21.5 | 5.1 | 0.023 |
| How do you rate the train in terms of hygiene level and cleanliness | 1 | 14.1 | 12.1 | 37.6 | 31.5 | 4.7 | 0.040 |
| | 2 | 12.1 | 12.1 | 37.6 | 31.5 | 4.7 | 0.040 |

Table 4
Solutions to encourage continuing to travel by train.

| Solution | Survey 1 |  |  |  |  | \"Strongly Agree\" | P-value |
|----------|----------|---|---|---|---|----------------|--------|
| Thin out the number of passengers so that the number of passengers will be only the number of seats | 1 | 18.6 | 19.0 | 20.7 | 21.9 | 19.8 | 0.004 |
| | 2 | 11.4 | 10.1 | 12.5 | 21.5 | 32.4 | 0.045 |
| Arrange passenger seating so that they are 2 m away from each other, for example in window and aisle seats | 1 | 9.7 | 10.1 | 24.5 | 27.8 | 27.8 | 0.000 |
| | 2 | 8.1 | 9.4 | 19.5 | 20.1 | 34.3 | 0.233 |
| Add a partition between any two seats | 1 | 16.9 | 13.1 | 22.4 | 19.0 | 28.7 | 0.058 |
| | 2 | 10.1 | 12.1 | 20.1 | 20.1 | 37.6 | 0.000 |
| Require the use of a mask | 1 | 7.2 | 5.1 | 14.3 | 20.7 | 52.7 | 0.000 |
| | 2 | 4.0 | 6.0 | 12.8 | 11.4 | 65.8 | 0.040 |
| Check temperature of each passenger on entry to the train station | 1 | 12.2 | 10.1 | 21.1 | 13.1 | 43.5 | 0.040 |
| | 2 | 8.1 | 8.7 | 12.8 | 10.7 | 59.7 | 0.000 |

We found a positive and statistically significant correlation between a person's belief that train travel has been a source of infection for diseases such as the flu, and the decision whether to travel by train (P-value = 0.000).
Table 5 describes the impact of the coronavirus on the decision to travel by train for specific scenarios, based on trip purpose, ranging from 1 (“does not affect the decision at all”) to 5 (“very much affects the decision”). As shown in Table 5, there is a decreasing trend in the score average for all three scenarios and all the trip purposes except for that of traveling for work. This means that the effect of the coronavirus pandemic on the decision to travel by train decreases over time and increases with the perceived to-be-increasing strength of the pandemic. With regard to work purpose, one can see that even in the case of a weakened outbreak of coronavirus, the average of the score was the highest; meaning that the existence of a limited outbreak of coronavirus accompanied by complete resumption of routines significantly affects the decision to travel by train. This result can perhaps be explained by the frequency of travel for commuting purposes and the high cumulative risk of exposure to infection, while travel for other purposes is more occasional in nature.

In addition, we conducted a Paired Samples t-Test to examine the statistical significance of differences between scores of the three scenarios for every trip purpose; the results are shown in Table 6. Based on the table, when traveling for work purposes an insignificant increase was seen in the score when shifting from scenario A to scenario B, with a significant decline in the score when shifting scenario B to scenario C. For the work matter purpose and other purposes, an insignificant decline was seen when shifting from scenario A to scenario B, while for the education purpose the decline was statistically significant (p = 0.031).

Among all trip purposes, the decline in moving from scenario B to scenario C was statistically significant, except for travel for other purposes; there the decline between the scenarios was statistically insignificant.

Table 6
Statistical significance of differences in scores between the three scenarios, by trip purpose (Paired Samples Test).

| Trip purpose       | Mean difference | S.D  | Sig   |
|--------------------|-----------------|------|-------|
| Work               |                 |      |       |
| 1 —> 2             | -.071           | 1.146| .442  |
| 1 —> 3             | .381            | 1.602| .005  |
| 2 —> 3             | .470            | 1.365| .000  |
| Work matter        |                 |      |       |
| 1 —> 2             | .086            | 1.143| .356  |
| 1 —> 3             | .394            | 1.511| .002  |
| 2 —> 3             | .331            | 1.258| .002  |
| Education          |                 |      |       |
| 1 —> 2             | .148            | .828 | .031  |
| 1 —> 3             | .338            | 1.322| .003  |
| 2 —> 3             | .215            | 1.252| .041  |
| Other              |                 |      |       |
| 1 —> 2             | .036            | 1.109| .674  |
| 1 —> 3             | .218            | 1.575| .086  |
| 2 —> 3             | .205            | 1.383| .062  |

In the second survey the questionnaire presented two realistic scenarios that describe the current situation. In the first scenario a partial return to normal life and routine occurs while the corona outbreak continues. This scenario describes the existing situation at this period. In the second scenario there is a full return to routines, most of the population has been vaccinated, and the pandemic has essentially disappeared.

Table 7 describes the impact of the coronavirus on the decision to travel by train for these two scenarios by trip purpose, ranging from 1 (“does not affect the decision at all”) to 5 (“very much affects the decision”). As was shown in Table 6, there is a decrease in the score average in the second scenario for all trip purposes. This means that the effect of the coronavirus pandemic on the decision to travel by train

Table 7
Average score for the two scenarios by trip purpose.

| Trip purpose       | Mean | S.D  |
|--------------------|------|------|
| Work-currently     | 3.114| 1.605|
| Work-after vaccination | 2.846 | 1.584 |
| Work-matter-currently | 3.020 | 1.629 |
| Work-matter-after vaccination | 2.772 | 1.556 |
| Education-currently | 2.940 | 1.649 |
| Education-after vaccination | 2.564 | 1.504 |
| Other-currently    | 2.933 | 1.765 |
| Other-after vaccination | 2.738 | 1.612 |
decreases after the vaccination. With regard to the work purpose, one can see that in the two scenarios, the average of the score was the highest.

In addition, we conducted a Paired Samples t-Test to examine the statistical significance of differences between scores of the two scenarios for every trip purpose; the results are shown in Table 8. Based on the table one can see that among all trip purposes, the decline in moving from the first scenario to the second scenario was statistically significant.

Assuming that the first scenario in the first survey is equivalent to the first scenario in the second survey, the scores in the first survey are significantly higher than the scores in the second survey among all the trip purposes. Thus, the lower the risk perception the less the impact of the coronavirus on the participants’ decision to travel by train. Furthermore, assuming that the third scenario in the first survey is equivalent to the second scenario in the second survey, the scores in the first survey are significantly higher than the scores in the second survey among all the trip purposes. This means that in the first period of the coronavirus outbreak while the train services were being shut down, the people were more worried and afraid of being infected by the coronavirus. Thereafter, through the passage of time and their observations, people became more familiar with the new pandemic disease and gained more experience with the possibilities of becoming infected while traveling by train. In addition, the development of vaccines and systems for their administration also maybe have had an impact on the decision to travel by train in the long term.

6.4. Factor analysis

Finally, we conducted a factor analysis to identify the relationship between attitudinal variables and the effect of coronavirus on the decision to travel by train. To this end we combined the two surveys; this decision was taken after conducting the factor analysis separately for every survey, where the results thereof showed very similar findings with regard to the number of the latent variables, the items, and the Cronbach’s Alpha test results. After excluding one factor (risk perception of being infected by the flu), which failed to demonstrate internal reliability (Cronbach’s Alpha > 0.65), we retained three factors: (1) train attribute, (2) fatalism, and (3) hygiene. Risk perception was measured by one item, “To what extent do you think travel by train has been a source of disease infection?” The components of these variables are summarized in Table 9.

6.5. The structural equations model

The analysis of joint decision-making was performed using AMOS (SPSS, 2012). Fig. 5 presents the final model and Table 10 summarizes the results of the structural equation model. In order to understand the long-term influence of the coronavirus, the model was applied only for work purposes and for the third scenario, when there is a full return to routines after the coronavirus pandemic has passed.

To test the fit of the model, the following fit indices were used: the comparative-fit index (CFI), and root mean-square-error-of-approximation (RMSEA). Values greater than 0.90 for CFI and lower than 0.06 for RMSEA indicate a good fit (Duncan 1975; Pedhazur and Pedhazur-Schemelkin 1991; Kerlinger and Lee 2000; Byrne 2001; Bagozzi and Yi 2012). After testing several decision models, in the final model, the adjusted goodness-of-fit index (CFI) equals 0.961, and the root mean square error of approximation (RMSEA) equals 0.045.

The demographic and socio-economic variables, along with the (latent) hygiene variable, failed to have a significant impact on the decision to travel by train for work purposes. They also failed to have a significant impact on the other latent variables such as fatalism and risk perception. Therefore, these variables were omitted from the model. A negative and statistically significant relationship was found between the frequency of traveling by train and the belief that the train is a source of disease infection: the more a person travels by train the less strong is the belief that travel by train is a source of infection ($\beta = -0.15, p < 0.02$). This result can perhaps be explained by learning from experience that the probability of infection from train travel is indeed low. No significant relationship between the fatalism and the risk perception was found ($\beta = 0.08, p < 0.133$).

There is a positive and statistically significant relationship between the belief that traveling by train is a source of disease infection and the decision to travel by train. The greater the belief that travel by train is a source of infection the greater impact on our decision to travel by train ($\beta = 0.17, p = 0.002$). This means that increasing risk perception creates a reluctance to travel by train, even after vaccination. The results show a positive and statistically significant relationship between train attributes (saving time, comfort, possibility of working, and certainty of arrival on time at destination) and the decision to travel by train ($\beta = 0.16, p < 0.006$). This means that train attributes have a great impact on the travelers’ decision to continue traveling by train, and the higher scores of train attributes indicates the greater impact of these attributes in the decision to travel by train. A negative and statistically significant relationship exists between trip frequency by train for work and the decision to travel by train for work purpose ($\beta = -0.17, p = 0.001$).

In sum, the study’s results show, when looking to the longer-term future, that when the government decides to return to full operation of the train in Israel and after the vaccination regimen has been essentially completed, the need to travel by train for work purposes at a high frequency will outweigh the perception of risk of being infected by coronavirus. Thereafter, the more frequent the trips the less will be the perceived risk. On the other hand, the greater the belief that the train is a source of infection, the greater the effect on the decision to use the train. The attributes of the train play an important role in the choice of the means of travel.

7. Discussion and conclusions

The current study examined an array of less-studied factors, such as attitudes and beliefs toward train use, including risk perception of flu-type infection in general and COVID-19 in particular, alongside more traditional factors, which together affect the decision to continue using the train.

We found that the correlation between risk perception of infection and the decision to continue traveling by train is statistically significant. This result is consistent with the reported data in Israel about the sharp decline in the demand for train travel (Asaf, 2020) to levels nearing 15% of the average demand. We also found that the frequency of train travel decreases the perception of risk. This contrasts somewhat with our previous finding that travel frequency increases the risk perception of being involved in road crashes (Elias and Shifman 2012).

Similar to many other studies that looked at travel for work purposes (Hadiuzzaman et al., 2019; Paulley et al., 2006), our study found that train attributes including time-saving, comfort, reliability, and the possibility of working on the train have a significant impact on the decision to continue traveling by train. Here, saving time is the most important variable, followed by the certainty of arrival on time at the destination.
Consistent with Rajeshwari & Tamilchelvi (2014); Litman (2013); and Patrunia et al., (2018), our results demonstrate the effect that the importance of the trip’s purpose has on the decision to use rail transportation. In examining the impact of coronavirus on the decision to continue traveling by train, we found that the initial impact of coronavirus was strongly negative with regard to expected continued use of the train. However, this was followed by a positive trend for the situation in which the pandemic weakens. This result varies, however, depending on the trip’s purpose. Applying a Pearson chi-square analysis, we found statistically significant differences between the trip purposes (p value = 0.007) and the impact of coronavirus on the decision to continue traveling by train. Consistent with Troko et al. (2011), our results show that about 18% of the participants report having been infected by flu while traveling by train. This result is also consistent with Goscé & Johansson (2018), who suggest that train travel is a source of the spread of infectious diseases.

There has been recent research on the social and economic impact of the coronavirus on various countries (Badger, 2020; Brooks et al., 2020; Carrington, 2020). The impact on travel behaviors has been investigated by many researchers and organizations (Zhang, 2020; Zhang et al., 2020). Shifting travel modes and greater reliance on private car travel is an expected result of the ongoing social distancing practices brought about by the pandemic. The Zhang (2020) study results suggest that the largest modal shift was from public transportation to private car (64.8%). This result should indicate the urgent need for intervention programs in order to maintain preferences for using public

Table 9
Summary of the factor analysis.

| Factor   | Variable statements                                                                 | Mean  | Variance | Cronbach’s Alpha |
|----------|------------------------------------------------------------------------------------|-------|----------|------------------|
| Train Attribute | Comfort (question 1)  
Possibility of working (question 3)  
Certainty of arrival on time at destination (question 4) | 2.93  | 1.11     | 0.801            |
| Fatalism | Each man’s fate is pre-determined, and it is very difficult to change it (question 5)  
Whatever needs to happen will happen – if a person’s fate is to be infected with coronavirus, he will be (question 6)  
If a person’s fate is to be infected with coronavirus, it does not matter if he travels by train or any other travel means (question 7) | 2.04  | 1.06     | 0.888            |
| Hygiene | How would you rate the train in terms of hygiene level and cleanliness  
How would you rate the train station in terms of hygiene level and cleanliness | 2.82  | 1.03     | 0.801            |

Table 10
Estimation results of the structure equation model.

| Variable                  | Estimate | Standardized (β) | S.E. | C.R. | P    |
|---------------------------|----------|------------------|------|------|------|
| Risk perception           | frequency | -.201             | .087 | -2.320 | .020 |
| Risk perception           | fatalism  | .086              | .050 | 1.504 | .133 |
| Certainty of arrival time at destination | train properties | 1.000         | .074 | 9.274 | *** |
| Possibility of working    | train properties | .668           | .002 | 13.667 | *** |
| Saving time               | train properties | 1.061         | .078 | 13.447 | *** |
| Comfort                   | train properties | .922           | .074 | 13.447 | *** |
| Travel by train to work   | Risk perception | .218           | .071 | 3.078 | .002 |
| Question 5                | fatalism  | 1.000             | .056 | 19.999 | *** |
| Question 6                | fatalism  | 1.121             | .055 | 18.094 | *** |
| Travel by train to work   | frequency  | -.223             | .079 | 2.722 | .001 |
| Travel by train to work   | train properties | .216           | .163 | 1.03  | 0.801 |

Fig. 5. Final model.

Consistent with Rajeshwari & Tamilchelvi (2014); Litman (2013); and Patrunia et al., (2018), our results demonstrate the effect that the importance of the trip’s purpose has on the decision to use rail transportation. In examining the impact of coronavirus on the decision to continue traveling by train, we found that the initial impact of coronavirus was strongly negative with regard to expected continued use of the train. However, this was followed by a positive trend for the situation in which the pandemic weakens. This result varies, however, depending on the trip’s purpose. Applying a Pearson chi-square analysis, we found statistically significant differences between the trip purposes (p value = 0.007) and the impact of coronavirus on the decision to continue traveling by train. Consistent with Troko et al. (2011), our results show that about 18% of the participants report having been infected by flu while traveling by train. This result is also consistent with Goscé & Johansson (2018), who suggest that train travel is a source of the spread of infectious diseases.

There has been recent research on the social and economic impact of the coronavirus on various countries (Badger, 2020; Brooks et al., 2020; Carrington, 2020). The impact on travel behaviors has been investigated by many researchers and organizations (Zhang, 2020; Zhang et al., 2020). Shifting travel modes and greater reliance on private car travel is an expected result of the ongoing social distancing practices brought about by the pandemic. The Zhang (2020) study results suggest that the largest modal shift was from public transportation to private car (64.8%). This result should indicate the urgent need for intervention programs in order to maintain preferences for using public
transportation. Our study of preference data demonstrates that there are measures that can be effective in encouraging people to keep traveling by train. Our results show that requiring use of a mask, checking temperatures, preventing people with the flu from traveling by train, and imposing fines on those who do travel while sick with the flu, are the most important measures.

Understanding and predicting travel behaviors is vital for transport planning, decision making, and policymaking during pandemic situations, all based on the travel needs of people. In the new situation created by COVID-19, policymakers should make efforts to avoid increased dependence on private car travel after the pandemic, which may result from adverse reactions to public transport services (Zhang (2020). The historical experiences of policy efforts to reduce car dependence should be dealt with as learned, and increased car use should be prevented, or at least significantly reduced, by further improving public transport services and promoting their use (Zhang; 2020; Wilder-Smith, 2020). The study results highlight the importance of many attributes favorably associated with train travel, including safety, time reliability, and comfort. It is also important to decrease the risk perception of being infected by coronavirus and other kinds of infected diseases. This can be addressed by creating a clean and reasonably sterile environment, for instance, by distributing hand sanitizer and masks everywhere in the train and in the station, for passenger use before and after they board the train. Future work should extend this preliminary study to larger and wider geographical samples, as well as to engage in testing other attitudinal variables and possible factors by applying various behavioral theories and travel behavioral models.

Author statement
Elias Wafa: Conceptualization, Methodology, Data analysis, Writing the Original Paper, Reviewing and Editing the Paper after Review. Sunbola Zatme-Kanj: Writing the Questionnaire, Collecting Data.

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