Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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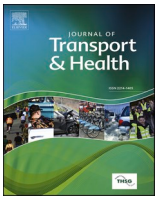

Explaining trip generation during the COVID-19 pandemic: A psychological perspective

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ABSTRACT

Introduction: The present study investigated the extent of reduction in the generation of non-essential trips (i.e., for shopping, personal, social, and entertainment reasons) due to the COVID-19 pandemic and the role of psychological factors (including deliberate planning and personal moral obligations) in explaining the change.

Method: We collected data through an internet survey conducted from April to June 2020. We recruited the respondents (N = 369) from a young segment of the population in Iran. The hypothesised model framework included the components of the theory of planned behaviour (including attitudes, subjective norms, perceived behavioural control, and intention to reduce non-essential trips) along with personal moral obligation. The framework also consisted of socio-demographic characteristics of age, gender, income, car ownership and trip distance. A structural equation model was developed to explain trip reduction at an aggregated level for four non-essential trip purposes (i.e., shopping, personal, social, and entertainment). In the aggregated model, trip-reducing behaviour represents the change in the number of trips for all non-essential purposes. We also tested the same framework, to explain trip reduction for each of the trip purposes, separately.

Results: On average, the study participants reduced their non-essential trips by 60% during the pandemic compared with in the pre-COVID-19 period. Men were less likely than women to reduce the rate of their trips during the pandemic. The SEM demonstrated that the theory of planned behaviour predicted trip-generation behaviour during the abnormal situation represented by the pandemic. Perceived behavioural control both directly and indirectly impacted trip reduction. However, personal moral obligations failed to provide a direct explanation for trip generation reduction. According to the hypothesised model, the results for different trip purposes were also mostly in line with those from the aggregated model.

Conclusions: The findings imply that participants in our sample made deliberate and planned psychological decisions (aligned with the theory of planned behaviour) regarding potential travel behavioural decisions during the COVID-19 pandemic. The findings also highlighted that perceived behavioural control grows in importance alongside growth in difficult circumstances.

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1. Introduction

The COVID-19 pandemic has substantially influenced everyday life around the world. In order to gain some degree of control over the rate of spread of the disease (the r-number[1]) and to avoid health system overload, various authorities have set restrictions on essential activities by temporarily closing schools, universities, and workplaces. Early on in the pandemic, several countries tried to discourage personal, economic, and shopping trips in favour of using well-developed digital systems (Van Bavel et al., 2020; Musselwhite et al., 2020). However, despite lockdowns, many people still undertook non-essential trips as they would in normal everyday life. This was particularly the case in regions where the authorities did not provide sufficient specific facilities, such as food delivery systems, online banking services, and online entertainment, and some people still undertook trips and continued outdoor activities (Gargoum and Gargoum, 2021). For instance, the spread of the SARS-CoV-2 coronavirus was out of control in the early phases of the outbreak in Iran. By February 2020, the r-number had reached 4.7, which as of today (January 2022) is the highest ever since the outbreak of the disease COVID-19 caused by the SARS-CoV-2 coronavirus in the country.[2]

A review of the literature revealed that there is no certain knowledge about how psychological variables influenced non-essential trips during the outbreak of the SARS-CoV-2 virus in 2019, and specifically between February, when the first COVID-19-related deaths occurred in Iran, and April 2020, when our survey started. In particular, there is no knowledge about how and to what extent attitudes, subjective norms, perceived behavioural control, and personal moral obligation regarding the need to stay at home and to stop making trips during the COVID-19 pandemic could relate to trip reduction decisions. Both from normative and descriptive perspectives, it is known that people around the world have been encouraged to reduce their non-essential trips during the pandemic. In this study, trip generation reduction refers to fewer than normal non-essential trips undertaken during the COVID-19 pandemic compared with the corresponding rate of trips taken prior to the pandemic.

We focus on attitudes towards behaviour, subjective norms, perceived behavioural control, and intentions, as well as personal moral obligation. With regard to mobility during the COVID-19 pandemic, it is assumed that a reduced rate of generated trips for non-essential purposes compared with the time prior to the pandemic can indicate travel behaviour that promotes public health. According to Ortúzar and Willumsen (2011), the following are defined as non-essential trips: (1) shopping, (2) personal (e.g., banking or appointment to see a doctor), (3) social (e.g., to go to a party, to visit friends), and (4) entertainment (e.g., to go to a park or cinema).

Based on the results of an Internet survey (n = 369) conducted among a young segment of the population (i.e., university students), this study contributes knowledge about travel behaviour by investigating whether underlying psychological factors alongside socio-demographic attributes could be associated with trip reduction during the early phases of the COVID-19 pandemic in Iran. The main aims of the study were to (1) investigate how much the students reduced their non-essential trips during the pandemic, and (2) test how, and to what extent, psychological factors could explain such travel behaviour. In this article we include policy and planning recommendations for policymakers, with the aim of alleviating the side effects of transport on the spread of viruses, such as coronaviruses in the study sample.

1.1. A review of the literature

Several studies have reported that different decisions in transport domains (e.g., mode choice, activity-travel context, making trips, safety) can be explained by psychological factors with different theoretical roots. Among the psychological constructs that are in some cases reported as influential predictors of travel behaviour are beliefs (including attitudes, subjective norms, and perceived behaviour control), personal norms (moral obligations), habits, risk perceptions, motivations and priorities (Hoffmann et al., 2017). From a theoretical point of view, travel behaviour, such as trip generation, can be explained through different well-established theories, including a more deliberate and planned psychological process in the theory of planned behaviour (Ajzen, 1991; Zavareh et al., 2020) and normative processes (De Groot and Steg, 2009; Nordfjærn and Rundmo, 2019).

Our literature review revealed that the theories have found significant correlates of travel behaviour under normal circumstances (e.g., Thorhauge et al., 2016; Mehdizadeh et al., 2019). Several studies have shown that with respect to the theory of planned behaviour, people's beliefs toward a target behaviour can influence their travel behaviour (e.g., Kroesen et al., 2017; Heath and Gifford, 2002; Zavareh et al., 2020; Thorhauge et al., 2016; Jacques et al., 2018; Kroesen and Chorus, 2020).

Attitudes refer to favourable or unfavourable evaluations of a target behaviour (e.g., sustainable transport use versus car use), whereas subjective norms concern how people perceive what significant others think about their behaviour. The perceived ability or possibility to control one's behaviour refers to perceived behavioural control. The term 'intention' covers motivation to practise a particular behaviour in the future (Ajzen, 1991).

With regard to empirical findings, Kroesen and Chorus (2020), who used a psychological network model in their study, reported that favourable attitudes towards a specific transport mode positively influenced the use of that mode. Based on a sample of Norwegians, Şimşekoğlu et al. (2015) found that favourable attitudes towards public transport were associated with an increased intention to use public transport. More recently, Aaditya and Rahul (2021) found that psychological attitudes reduced people's essential and recreational trips compared with work trips during the COVID-19 pandemic. They conducted a web-based survey among 410 Indians and found that psychological factors could be a significant predictor of trip frequency during the pandemic. Studies have also shown that individual behaviour regarding transport decisions can be influenced by peers, family members, and friends (e.g., Abou-Zeid et al.,

[1] r is the number of people that one infected person will pass on a virus to, on average.

[2] https://www.theglobaleconomy.com/Iran/covid_reproduction_rate/.

2013; Nordfjærn et al., 2014). Nordfjærn et al. (2014) found that among different psychological components subjective norms was the strongest predictor of intention to use public transport. It has also been reported that, compared with weaker subjective norms, stronger subjective norms concerning sustainable transport options are positively related to intention to use sustainable transport modes (Klöckner and Blöbaum, 2010). In addition to attitudes and subjective norms, many studies have found that perceived behaviour control has a significant role in transport safety/travel behaviour. For example, Thorhauge et al. (2016) found that perceived behaviour control was significantly associated with departure time choice. Moreover, higher perceived behavioural control was found positively related to safe driving behaviour (Warner et al., 2009).

Although the cited factors are based on a deliberate and planned psychological process known as the theory of planned behaviour, personal moral obligations (personal norms) have been found significant predictors of behaviour (Steg and Vlek, 2009). Several environmental psychologists have reported that personal norms and obligations can affect pro-environmental behaviour (e.g., Steg and Vlek, 2009; Nordfjærn et al., 2019). Furthermore, studies conducted in Norway (Lind et al., 2015), the Netherlands (De Groot et al., 2008), Russia (Ünal et al., 2019), and Argentina (Abrahamse et al., 2009) found that people who reported stronger personal norms and obligations regarding the environment tended to use sustainable modes of transport.

With regard to socio-demographic variables, previous studies have reported the role of age, gender, car ownership, and income status in relation to trip generation. Individuals with high income and households that own more cars than other households were more likely to generate trips prior to the COVID-19 pandemic (Lucas and Jones, 2009; Metz, 2010). However, findings with respect to age and gender are inconsistent. For example, Tilley and Houston (2016) found that young women travelled more than young men, whereas Susilo et al. (2019) reported that men drove more than women, and that older adults made more trips by any mode of transport than younger people.

1.2. Hypothesised model

The relevant literature calls for a study to reveal how beliefs and personal norms can be related to trip reduction during the first wave of the COVID-19 pandemic. Although behavioural beliefs and personal norms have been found significant predictors of travel behaviour under normal circumstances, little is known about their relative roles during the COVID-19 pandemic. Accordingly, we developed a hypothesised modelling framework, combining the theory of planned behaviour and norm-activation theory to investigate whether such psychological factors could explain trip reduction during the pandemic. Since socio-demographic variables such as age and gender have been reported as direct predictors of trip generation under normal circumstances, we also examined the direct effects of such attributes on trip generation during the COVID-19 pandemic.

Regarding the theory of planned behaviour, we hypothesised that attitudes, subjective norms, perceived behavioural control, and intentions with regard to the side effects of mobility on the outbreak of the SARS-CoV-2 coronavirus could indirectly/directly facilitate a more significant trip reduction (i.e., a reduced rate of trips generated for non-essential purposes). According to the theory of planned behaviour, attitudes, subjective norms, and perceived behavioural control can be directly associated with intention. It has been also confirmed that perceived behavioural control and intention can have direct links to behavioural outcomes. Accordingly, we hypothesised five links (shown as arrows in Fig. 1) based on the theory of planned behaviour.

With regard to the normative theory, many studies have demonstrated that personal moral obligation can explain intention, as well as behavioural outcomes (e.g., Abrahamse et al., 2009; Jakovcevic and Steg, 2013). Hence, we hypothesised that personal moral obligation concerning side effects of mobility during the SARS-CoV-2 coronavirus outbreak could directly influence both intention and behaviour. Therefore, two additional links were added to the modelling framework. Although it might be expected that the spread of the SARS-CoV-2 coronavirus reduced trip generation even for non-essential purposes, existing knowledge is very limited regarding how and to what extent an individual's deliberate and planned behaviour, as well as normative processes, have influenced travel decisions during the COVID-19 pandemic. Hence, we aimed at revealing psychological correlates of travel behaviour during the pandemic. Furthermore, we examine how socio-demographic variables (e.g., age, gender, car ownership) could play a role in making trips in the same period.

In Fig. 1, the left-hand side of the hypothesised model incorporates latent psychological factors of the theory of planned behaviour,

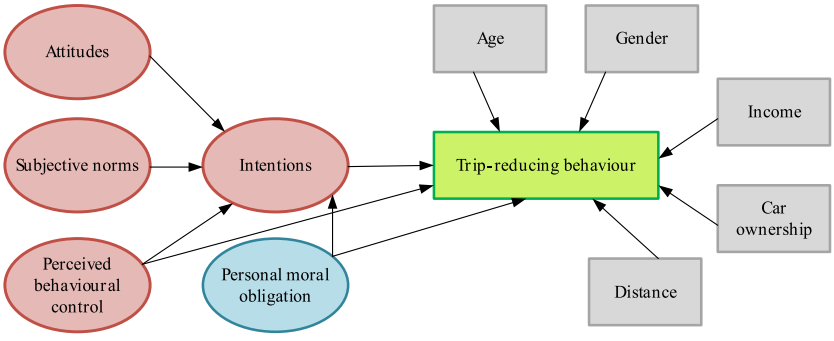

Fig. 1. The hypothesised model in the study.

as well as personal moral obligation, whereas other variables are manifest variables, such as age and gender, which are hypothesised to explain trip reduction behaviour. For instance, we hypothesised that women and older students would reduce their trips significantly more than men and younger students, respectively.

Based on the framework illustrated in Fig. 1, a model will be developed to explain trip reduction at an aggregated level for four non-essential trip purposes (i.e., shopping, personal, social, and entertainment). In the aggregated model, trip-reducing behaviour represents the change in the number of trips for all non-essential purposes. Additionally, there will be four more models that explain trip-reducing behaviour for each of the trip purposes, separately.

2. Method

2.1. Procedure and sample

The survey was conducted at Kharazmi University, which is among the oldest and largest universities based in Tehran, Iran. The first deaths from the COVID-19 outbreak in Iran were formally registered on February 19, 2020 (Hoseinpour Dehkordi et al., 2020). Health concerns about the outbreak grew rapidly in the early phases of the pandemic, and therefore the government decided to shut down all educational institutions in provinces with the worst outbreaks; among the institutions was Kharazmi University. The survey was started in April 2020, when the country experienced a temporary decline in the number of deaths from the SARS-CoV-2 coronavirus and it ended in June 2020 when a reverse upward trend was observed in the daily mortality rate.

Since Kharazmi University was shut down for a long period from the time the SARS-CoV-2 coronavirus was first detected and confirmed in Iran, and since we did not have access to the population's contact information, we conducted an Internet survey with non-probability sampling among students at Kharazmi University instead of random sampling. Despite concerns that have been raised regarding validity issues and potential inherent bias in Internet surveys (Braithwaite et al., 2003), the method has been widely used in recent transportation research (Klöckner et al., 2013; Zavareh et al., 2018, 2022; Zavareh et al., 2018; Zhang et al., 2020; Palm et al., 2021; Zavareh et al., 2022).

An online survey questionnaire was developed and uploaded into Google Docs. The survey started with an invitation letter that informed about the purpose of the study, and confidentiality of the study participants' data and responses. The participants IP addresses were not registered. The participants were assured that their anonymity would be preserved. In an attempt to increase the response rate, the invitation letter informed that six gift cards would be awarded following a draw. To be eligible for the draw the participants were asked to enter their contact details at the start of the survey. However, this option was strictly voluntary. The survey link was sent to students specialising in traffic/transport and members of student forums. We also asked the university's administration, educational staff, and professors to share the survey link with students after online lectures. The study participants were encouraged to share the link with their fellow students and friends at Kharazmi University. The snowball method of recruiting participants has been used in previous studies (Zavareh et al., 2018, 2022; Zavareh et al., 2018; Zavareh et al., 2022). The study was reviewed by the Norwegian Centre for Research Data (NSD) (reference 291,734), which gave approval for the data to be processed and analysed.

Of the 369 participants, 43% were men (n = 159). The average age was 22.12 years (SD = 3.18, range = 19–39) (Table 1).

2.2. Questionnaire

The first section of the questionnaire covered socio-demographic variables, including age, gender, car ownership status, income level, and household size. The second part was devoted to trip generation before and during the COVID-19 pandemic. We asked the participants: 'How often did/do you generally travel with the following trip purposes: (1) shopping, (2) personal (e.g., banking or for an appointment with a doctor), (3) social (e.g., to go to a party, to visit friends), and (4) entertainment prior to the COVID-19 pandemic/during the COVID-19 pandemic[3]?' The responses were scored on a Likert scale ranging from never (0) to seven times or more a week (7).

Regarding psychological items, we asked the participants to report to what extent they agreed or disagreed in general with the statements relating to attitudes (Table 2). The responses were scored on a five-point Likert scale (range: 1 – strongly disagree to 5 – strongly agree). Attitudes towards trip generation during the COVID-19 pandemic were measured by seven statements such as "I think it is very necessary to reduce my daily travels during the COVID-19 pandemic" (see detailed items in Table 2). Subjective norm was assessed by six items, such as "If people around me stay at home, this will prompt me to stay at home during the COVID-19 pandemic", while perceived behavioural control was evaluated by four items, such as "I can to a large extent decide whether or not to stay at home during the COVID-19 pandemic". Intention was measured by three statements, such as "I am willing to stay at home during the COVID-19 pandemic". Moreover, personal moral obligation was also evaluated by two items, such as "Because of my own principles I feel an obligation to stay at home during the COVID-19 pandemic". The validity of the psychological measurements and the questionnaire was checked by a panel of experts, and the survey instruments were tested through a pilot survey conducted among 10 students. Moreover, the applied test battery is strongly rooted in psychological theories and have been used in many different settings previously (e.g., Warner et al., 2009; Zavareh et al., 2020; Thorhauge et al., 2016; Ünal et al., 2019).

[3] The period covered by the survey was not the entire period of the pandemic.

Table 1
Sample characteristics.

Attribute	Min	Max	Mean	Std. Dev.	
Age	19	39	22.12	3.18	
Gender	Men (n = 159; 43%)		Women (n = 210; 57%)		
Distance to the university	Less than two km (19.5%)	2–5 km (10.3%)	5–10 km (13.0%)	20–20 km (10.3%)	More than 30 km (34%)
Income	Very low (7.3%)	Low (23.3%)	Moderate (49.6%)	High (18.4%)	Very high (1.4%)
Car access	Yes (41.2%)	No (58.8%)			

Table 2
Psychological items in the questionnaire.

Attitudes ($\alpha = 0.86$): ATT1. I think it is really necessary to reduce my daily travels during the COVID-19 pandemic. ATT2. I think staying at home is a good choice during the COVID-19 pandemic. ATT3. I support the introduction of strong policies to encourage individuals to stop making trips during the COVID-19 pandemic. ATT4. I think making trips during the COVID-19 pandemic is very dangerous for public health. ATT5. I think driving is an irrational decision during the COVID-19 pandemic. ATT6. I think it is unsafe to use public transport during the COVID-19 pandemic. ATT7. I think walking/cycling is a way of spreading the virus during the COVID-19 pandemic.

Subjective norm ($\alpha = 0.80$):

SN1. If people around me stay at home, this will prompt me to stay at home during the COVID-19 pandemic.
SN2. Most people who are important to me think I should not make trips during the COVID-19 pandemic.
SN3. News media prompt me to reduce my daily mobility during the COVID-19 pandemic.
SN4. People who have an influence on me (such as family and friends) think that driving is not a rational decision during the COVID-19 pandemic.
SN5. Most people who are important to me think that it is unsafe to use public transport during the COVID-19 pandemic.
SN6. Most people who are important to me think walking/cycling is a way of spreading virus during the COVID-19 pandemic.

Perceived Behavioural Control ($\alpha = 0.79$):

PBC1. I can to a large extent decide whether or not to stay at home during the COVID-19 pandemic.
PBC2. I have the ability to reduce my daily mobility during the COVID-19 pandemic.
PBC3. I am confident that if I want to buy something, I definitely would be able to use e-shopping rather than undertaking physical trips to shopping centres.
PBC4. I have the possibility of studying from home during the COVID-19 pandemic.

Intention ($\alpha = 0.90$):

INT1. I am willing to stay at home during the COVID-19 pandemic.
INT2. I plan to cancel my daily trips during the COVID-19 pandemic.
INT3. I intend to reduce my transportation mode use during the COVID-19 pandemic.

Personal moral norms ($\alpha = 0.89$):

PN1. Because of my own principles, I feel an obligation to stay at home during the COVID-19 pandemic.
PN2. I feel obliged to take the health consequences into account when making trips during the COVID-19 pandemic.

2.3. Analysis

We defined trip generation reduction as a reduction in non-essential trips undertaken during the COVID-19 pandemic compared with the corresponding value for the pre-pandemic period, expressed as[4]:

$$T_{TR,i} = \sum_{j=1}^{J} T_{COVID-19,i,j} - \sum_{j=1}^{J} T_{\mathrm{Pre}-COVID-19,i,j} \quad (1)$$

where.

$T_{TR,i}$ is the absolute change of generated trips for non-essential purposes (the aggregation of four trips purposes) during the COVID-19 pandemic compared with pre-COVID-19 pandemic for the participant *i*.
$T_{COVID-19,i}$ is the generated trips for trip purpose j during the COVID-19 pandemic for the participant *i*.
$T_{\mathrm{Pre}-COVID-19,i}$ is the generated trips for trip purpose j in pre-COVID-19 pandemic for the respondent *i*.

As illustrated in Fig. 2, the value of T_{TR} ranges from -20 to 11 in our analysis. In line with our expectation, most values are negative, due to a reduction in the rate of trips during the COVID-19 pandemic. Over 93% of respondents had reduced their non-essential trips. While a value approaching -20 indicated the greatest reduction in trips, zero and positive values reflected no and increased trip generation during the COVID-19 pandemic, respectively. Moreover, the frequency of absolute change of generated trips for each of non-essential purposes are shown in Appendix A.

Structural equation modelling (SEM) was carried out to test how different psychological variables were related to the outcome variable (i.e., trip reducing behaviour). We used the IBM SPSS AMOS 23.0.0 software for SEM analysis. Various indices were used to assess the goodness of fit of the hypothesised integrated framework illustrated in Fig. 1. The comparative fit index (CFI) and the

[4] In addition to the above-aggregated definition, which was used in the main (aggregated) SEM analysis, four other models were also constructed based on four trip purposes (i.e., shopping, personal, social, and entertainment).

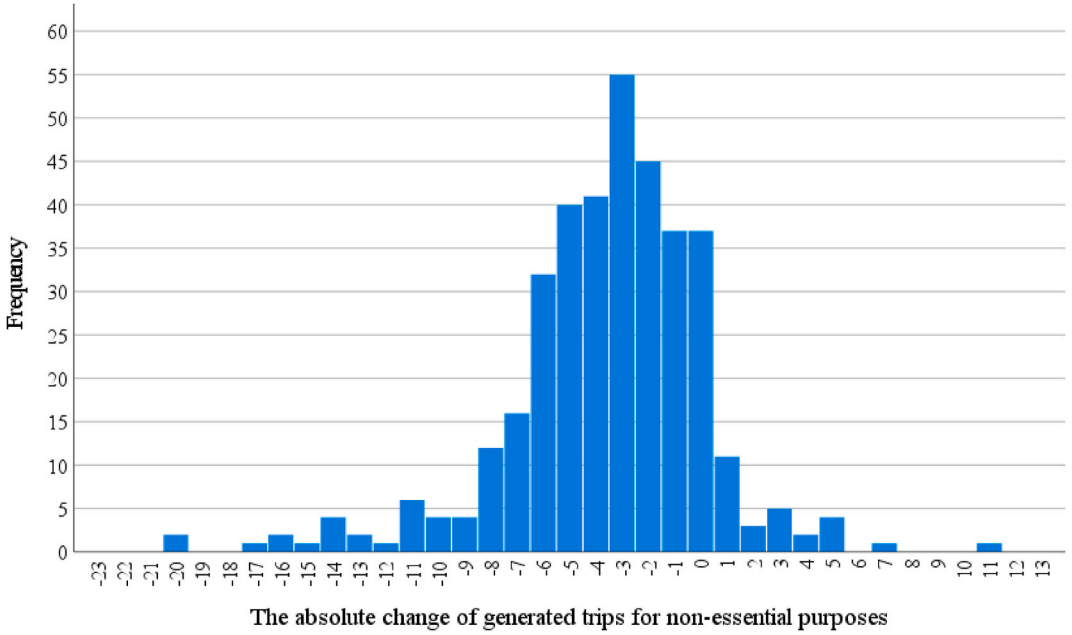

Fig. 2. The frequency of absolute change of generated trips for non-essential purposes (at the aggregate level).

Tucker-Lewis Index (TLI) were used to evaluate the fit of the developed model. CFI and TLI values between 0.90 and 0.95 reflect adequate model fit (Kline, 2015). We also used the root mean square error of approximation (RMSEA), where values less than 0.06 are considered a good fit (Kline, 2015). Additionally, the chi-square value and the corresponding level of significance were calculated. Cronbach's alpha was used to test the reliability of scales and indexes. Items that were not statistically significant in the confirmatory factor analysis (CFA) ($p > 0.001$), and items that had a factor loading less than 0.4 were removed from the model (Ho, 2006).

3. Results

The results of the descriptive analysis showed that participants in our sample significantly reduced the rate of trips for non-essential purposes during the COVID-19 pandemic compared with before the onset of the pandemic. Average percentage change for trip generation was around -60% in the sample. Fig. 3 shows the extent to which the average rate of trips for various non-essential purposes was reduced during the COVID-19 pandemic compared with before the start of the pandemic. For instance, the strongest reduction was attributed to trips for personal purposes (e.g., banking).

Fig. 4 shows the dispersion (at 95% CI around the mean) of responses with regard to different psychological items. For example,

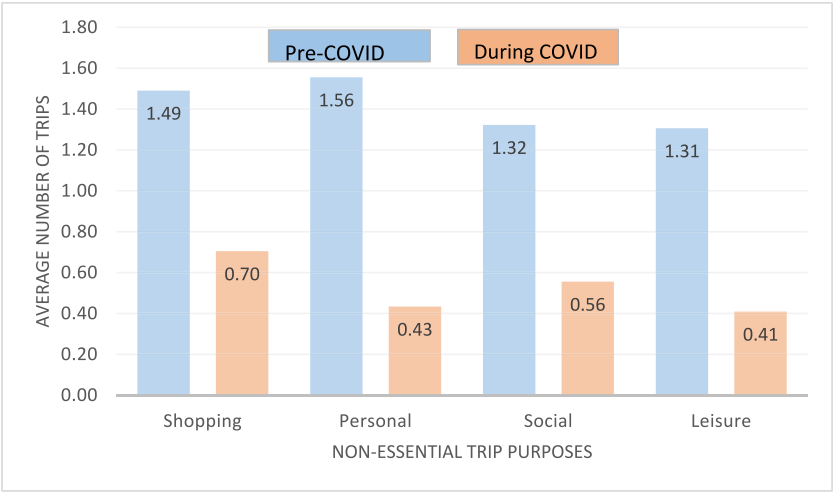

Fig. 3. Average rate of trips for non-essential purposes pre- and during the COVID-19 pandemic.

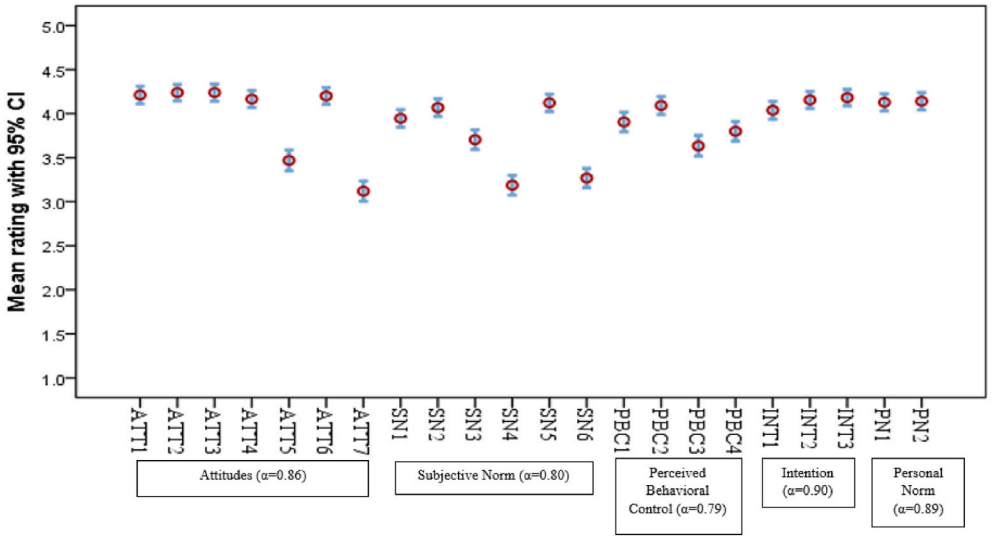

Fig. 4. Dispersion of psychological items.

among attitude items, items 5 ('I think driving is an irrational decision during the COVID-19 pandemic') and 7 ('I think walking/cycling is a way of spreading the virus during the COVID-19 pandemic') had a different dispersion than other items. Moreover, all the psychological constructs had a satisfactory Cronbach alpha (>0.78).

A gender disparity was found in trip generation (Fig. 5). We observed that women reduced their rate of trips more during the COVID-19 pandemic than men.

The next step was to examine correlations between the variables. As shown in Table 3, the four psychological components of the theory of planned behaviour and personal moral obligation were moderately positively correlated. Men tended to report weaker attitudes ($r = -0.14$), subjective norms ($r = -0.18$), perceived behavioural control ($r = -0.10$), personal moral obligations ($r = -0.12$), and less trip reduction behaviour ($r = -0.25$) than women. Moreover, all psychological constructs were positively correlated with higher rates of trip reductions.

The results of the main SEM analysis (the aggregated model) are shown in Fig. 6. The specific estimations are provided in more detail in Table 4. The model reflected satisfactory fit indices (chi-square/DF = 2.46, $p < .001$, CFI = 0.92, TLI = 0.92, RMSEA = 0.049). Estimates of standardised regression weights, variance in error terms, and squared multiple correlations are listed in Table 4. The model explained about 64% of the variability in intention to reduce trip generation. However, the variability in the ultimate outcome variable (i.e., trip reducing behaviour) was around 11%. The model demonstrated that the theory of planned behaviour framework has some explanatory power, also under abnormal circumstances. However, the link between personal norm (moral obligation) and behaviour was not found significant. Among psychological associations, the associations between attitudes and intention ($b = 0.192$, p

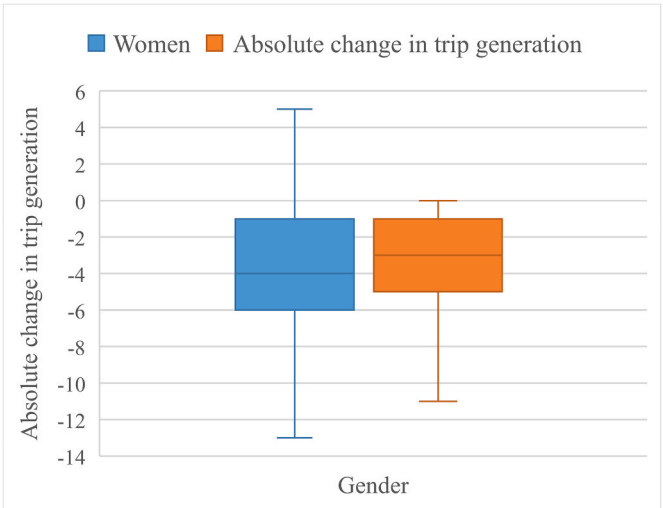

Fig. 5. Absolute change in trip generation among men and women.

Table 3
Correlation analysis between the study variables.

Variables	Gen	Age	Car	Dist	INC	ATT	SN	PBC	INT	PN
Gender (Gen); Men = 1, Women = .0										
Age; Continuous variable	-.02									
Car access (Car); Access = 1, otherwise = 0	.08	.02								
Distance (Dist); Ordered variable	.03	**-.15**	.03							
Income (INC); Ordered variable	.06	**-.20**	**.28**	**.16**						
Attitude (ATT)	**-.14**	.01	**.13**	.02	-.01					
Subjective Norm (SN)	**-.18**	.00	**.12**	-.04	-.03	**.79**				
Perceived Behavioural Control (PBC)	**-.10**	**-.11**	**.18**	.06	**.13**	**.68**	**.70**			
Intention (INT)	-.09	.02	**.14**	.00	.06	**.78**	**.76**	**.76**		
Personal Norm/Moral Obligation (PN)	**-.12**	.06	**.11**	.01	.02	**.75**	**.73**	**.71**	**.84**	
Trip Reducing Behaviour	**-.25**	.01	.02	.05	-.06	**.32**	**.28**	**.28**	**.30**	**.27**

Notes: Bold values are significant at 95% CI. Pearson correlation analysis was used for continuous variables, while non-parametric correlation analyses were used for ordinal and binary variables.

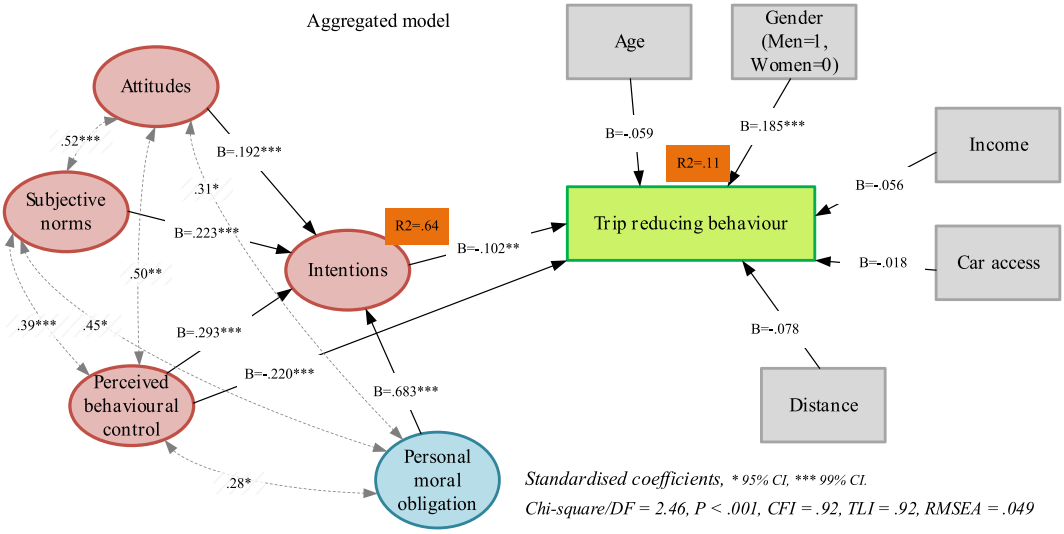

Fig. 6. Explanation of trip reducing behaviour through latent psychological and manifest variables.

< .001), subjective norm and intention (b = 0.223, p < .001), perceived behavioural control and intention (b = 0.293, p < .001), personal norm (moral obligation) and intention (b = 0.683, p < .001), as well as intention and trip reducing behaviour (b = -0.102, p < .01) were found statistically significant. Personal moral obligation was positively related to trip reducing intention (b = 0.683, p < .001). Among different observed variables, only female gender was found to be a significant predictor of trip reducing behaviour (b = 0.185, p < .001).

Four additional SEM-analyses were also tested using the same framework by four non-essential trip purposes (i.e., shopping, personal, social, and entertainment). All models reflected satisfactory fit indices. Estimates of standardised regression weights and squared multiple correlations are illustrated in Appendix B. The explained variability in the ultimate outcome variable was around 9%, 8%, 16%, and 11% for shopping, personal, social, and entertainment trips, respectively. The results of these models were mostly in line with the result of the aggregated model. A longer distance between home and the university was significantly associated with a reduction in social trips (p < .05). Additionally, older individuals were more likely to reduce their trips with entertainment purposes (p < .05).

4. Discussion and conclusions

Our empirical research showed that on average participants in our Iranian sample reduced their non-essential trips (i.e., for shopping, and for personal, social, and entertainment purposes) by 60% during the COVID-19 pandemic compared with in the pre-COVID-19 period. The hypothesised framework included the components of the theory of planned behaviour along with personal moral obligation. The framework also consisted of socio-demographic characteristics of age, gender, income, car ownership and trip distance. These explanatory variables were hypothesised to explain trip reduction. Explanatory variables accounted for 11% of the explained variance in observed trip reduction in the aggregated model. This value was, however, the highest (16%) for social trip purposes among the different non-essential trip purposes. Intriguingly, the findings indicate no significant differences among different

Table 4
Specific estimates in the SEM analysis.

			Estimate	S.E.	C.R.	p
Attitudes	—>	Intention	.144	.023	6.138	***
Subjective Norm	—>	Intention	.169	.024	7.120	***
Perceived Behavioural Control	—>	Intention	.212	.023	9.374	***
Personal Moral Obligation	—>	Intention	.464	.021	21.823	***
Income	—>	Trip Reduction	-.246	.221	-1.117	.264
Distance	—>	Trip Reduction	-.151	.098	-1.546	.122
Car Access	—>	Trip Reduction	-.135	.385	-.350	.726
Age	—>	Trip Reduction	-.070	.060	-1.180	.238
Gender	—>	Trip Reduction	1.572	.382	4.115	***
Perceived Behavioural Control	—>	Trip Reduction	-.972	.233	-4.173	***
Intention	—>	Trip Reduction	-.871	.322	-2.704	**
Intercepts						
Perceived Behavioural Control	—>	Trip Reduction	.115	.185	.619	.536
Intention	—>	Trip Reduction	3.116	2.056	1.516	.130
Variances						
Attitudes			.679	.050	13.565	***
Subjective Norm			.657	.048	13.565	***
Perceived Behavioural Control			.723	.053	13.565	***
Personal Moral Obligation			.823	.061	13.565	***
Error term_Intention			.137	.010	13.565	***
Income			.736	.054	13.565	***
Distance			3.761	.277	13.565	***
Car Access			.242	.018	13.565	***
Age			10.104	.745	13.565	***
Gender			.245	.018	13.565	***
Error term_Trip Reduction			13.187	.972	13.565	***
Standardised Regression Weights						
Attitudes	—>	Intention	.192			
Subjective Norm	—>	Intention	.223			
Perceived Behavioural Control	—>	Intention	.293			
Personal Moral obligation	—>	Intention	.683			
Income	—>	Trip Reduction	-.056			
Distance	—>	Trip Reduction	-.078			
Car Access	—>	Trip Reduction	-.018			
Age	—>	Trip Reduction	-.059			
Gender	—>	Trip Reduction	.185			
Perceived Behavioural Control	—>	Trip Reduction	-.220			
Intention	—>	Trip Reduction	-.102			
Squared Multiple Correlations						
Intention			.639			
Trip Reduction			.114			

Notes: * 95% CI, *** 99% CI. Two items of the attitude construct (ATT5 and ATT7) were removed from the analysis because they achieved a factor loading less than 0.4.

non-essential trip purposes in terms of structural relationships that lead to trip reduction behaviour. Our findings also showed that the theory of planned behaviour could predict trip generation during abnormal situations such as a global pandemic. This may imply that participants in our study made deliberate and planned psychological decisions (aligned with the theory of planned behaviour) of their potential travel behavioural decisions during the COVID-19 pandemic. However, personal moral obligation failed to directly explain trip reducing behaviour.

The finding that among different components of the theory of planned behaviour, perceived behavioural control both directly and indirectly impacted trip generation, highlights that perceived behavioural control grows in importance alongside growth in difficult circumstances. Students who reported that they were confident that they would be able to use e-shopping or had the possibility to study from home during the COVID-19 pandemic were more likely to reduce their rate of trips during the pandemic. Thus, policy-makers should be aware that providing adequate e-shopping facilities and e-studying tools could augment the control perception of travel behaviour. In other words, expanding the knowledge, quality, and availability of information technology and Internet infrastructure may discourage trip generation decisions during lockdowns.

Although personal moral obligation was found to be an insignificant direct predictor of trip generation reduction, it indirectly explained trip generation reduction. Intention had a mediating role between personal moral obligation and reduction. One plausible reason for why there was such an indirect effect instead of a direct behavioural link may be found in the study context and situation during the SARS-CoV-2 coronavirus outbreak in Iran. Even though students felt obliged to take the health consequences into account when undertaking trips during the pandemic, they still made some trips for non-essential purposes. This may highlight a lack of integrated programmes and regulations aimed at providing entertainment via the Internet and mass media (Habersaat et al., 2020), as well as safe food delivery systems and Internet banking services for citizens during the COVID-19 pandemic.

Overall, it can be concluded that psychological factors had stronger explanatory power for trip generation reduction than socio-

demographic variables. Akin to the latter set of variables, we found a significant gender disparity in trip generation in our Iranian sample. Men were less likely to reduce the rate of their trips during the pandemic than were women. This finding is in line with previous findings and theories that have shown that men conduct more risk-taking behaviour or are less likely to commit to rules and regulations than are women (DeJoy, 1992; Thom, 2003). Furthermore, the correlation analysis highlighted that men also reported weaker attitudes, subjective norms, and personal moral obligation than women. Hence, we suggest that policymakers should target men when establishing policy and interventions during a pandemic.

Our research had some limitations. First, the survey design was cross-sectional, an approach that can prevent causal inferences. Second, both explanatory and dependent variables in the SEM analysis were measured by self-reported items, which might have caused common method bias (Podsakoff et al., 2003), meaning that some significant relationships may be attributed to the method rather than actual associations between variables. Third, the sample was confined to students at one university in Iran and therefore the findings cannot be generalised to the wider public. However, it was not our aim that the results should be generalised to the general population or to all university students in Iran. Rather, we aimed at testing a conceptual model among a sample of university students. Due to the COVID-19 pandemic lockdown restrictions and lack of access to the population's contact information, we applied an Internet survey with convenience sampling, instead of a random sampling method. According to the university education office's data, women constituted 55.7% of the total students. Since our sample comprised 57% women, the ratio closely resembled that of the population as a whole. Regarding the number of original invitations, despite being able to count the number of times the invitation link was opened, the survey did not benefit from that option. This issue also stems from the fact that we aimed to conceal the identity of the study participants and maintain data confidentiality of the survey responses. As for the sample validation, we required all the questions to be answered by the participants before they could submit the questionnaire, which ensured that we did not have any missing data.

Although the intention to reduce the rate of non-essential trips is largely explained (64%) by psychological constructs in the theory of planned behaviour, the observed trip reduction was not substantially explained (11%) by the explanatory variables in the aggregated model. Future research/updated data might reveal the extent to which lockdown situations influence the explained variance of the (observed) reduction in non-essential trips. Even though the survey was conducted during the first wave of the SARS-CoV-2 coronavirus outbreak, the participants reported strong behavioural beliefs and intentions to reduce non-essential activities. Since the theory of planned behaviour proposes a planned psychological decision-making process (Bamberg et al., 2003; Verplanken and Orbell, 2003), the link between intention and the explained (observed versus actual) variance of trip reduction might be improved over time. To reveal to what extent the actual versus observed variance of trip reduction in the current waves and any future waves of the COVID-19 pandemic is a function of such a planned psychological process or lockdown effect, updated data/model using the same questionnaire as in our study should be conducted.

Authors' contributions

MM: The study design, literature review, manuscript writing, methodology, data preparation, formal analysis and investigation, model development, and interpretation of results, project administration, supervision. **MFZ**: Data collection, Manuscript editing, resources, validation. Project administration, supervision. **TN**: Conceptualization, draft manuscript editing, validation, project administration, supervision. All authors have read and approved the final manuscript.

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Author statement

Milad Mehdizadeh: Writing - original draft; Conceptualization; Methodology; Investigation; Formal analysis; Project administration; Visualization.

Mohsen Fallah Zavareh: Methodology; Data Collection; Validation; Project administration; Writing - review & editing;

Trond Nordfjaern: Supervision; Methodology; Project administration; Validation; Writing - review & editing.

Declaration of competing interest

The authors have no conflict of interest to report.

Data availability

The authors do not have permission to share data

Appendix A

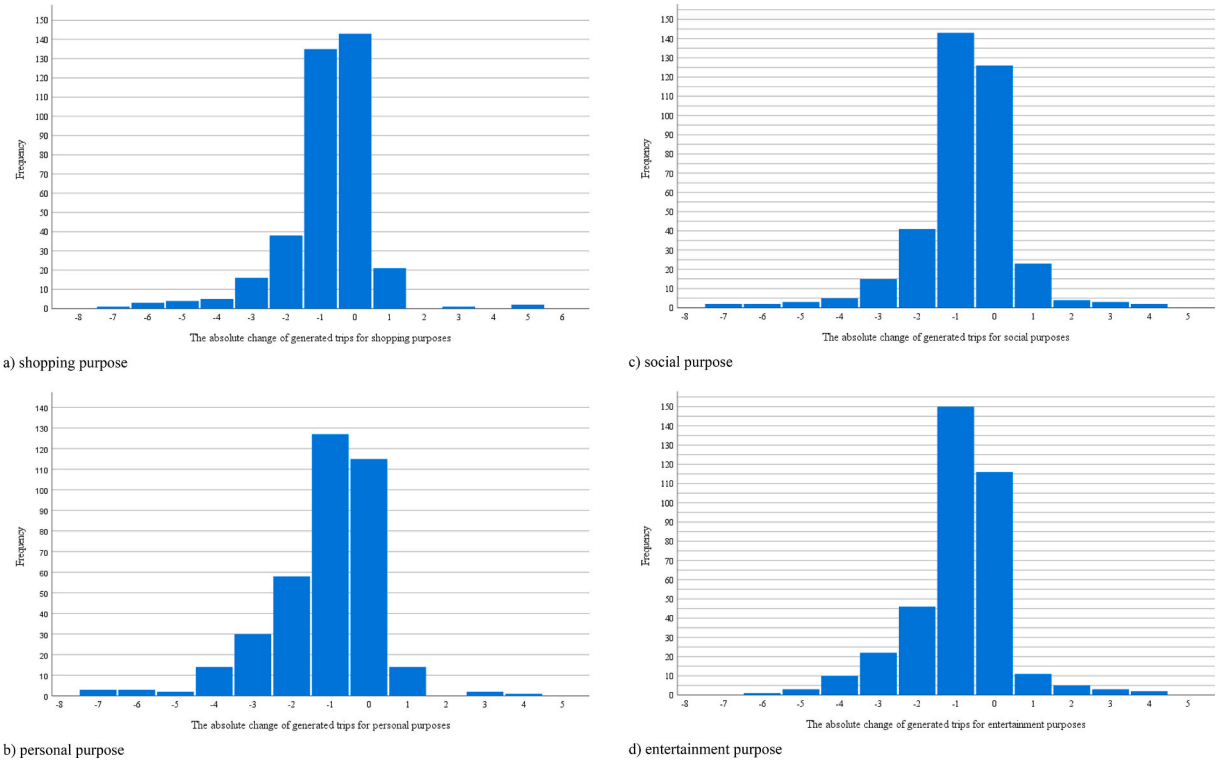

Fig. A. The frequency of absolute change of generated trips for each of non-essential purposes

Appendix B

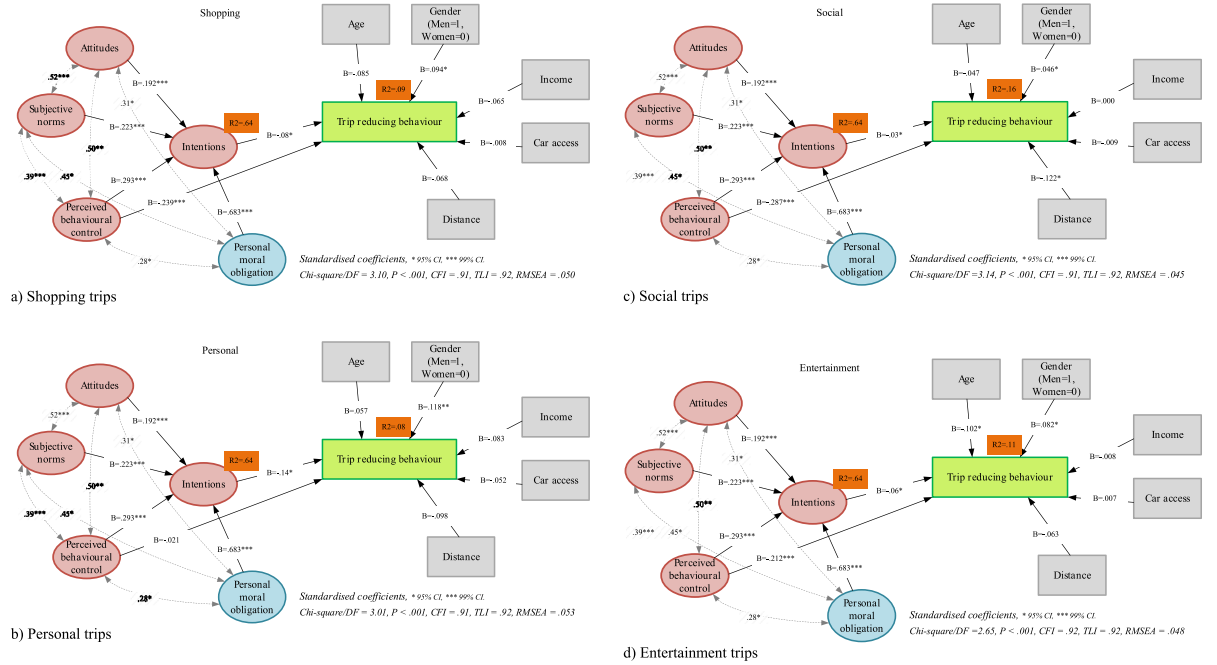

Fig. B. Explanation of trip reducing behaviour by non-essential trip purposes

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