Modeling the impact of normative messages on the propensity to change travel behavior

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Abstract

Prompted by previous research indicating associations between social norms and travel behavior, this study examines the effectiveness of a persuasive normative intervention on car commuters in Cagliari, Italy. The intervention provided (descriptive and/or injunctive) normative statements to encourage a shift from the car to a sustainable travel alternative, namely walking, cycling, or transit, suggested through a Personalized Travel Plan. An Integrated Choice and Latent Variable model allowed for controlling for level of service, socioeconomic, and psychological variables.

Results showed how the injunctive normative message significantly increased public transport intention, particularly when individuals perceived a higher level of behavioral control. However, no significant impact was found for active mobility. Pseudo-elasticity effects showed how the injunctive message had a similar impact as the travel time difference between cars and public transport.

This work is valuable for policymakers as it provides insightful best practices for low-budget normative messaging to promote sustainable travel behaviors.

Keywords

Social norms; Travel behavior change; Persuasive normative intervention; ICLV model; Messaging

1. Introduction

Over the last twenty years, following the seminal study of Dugundji and Walker (2005), there has been a growing interest in the influence of social interdependence on travel behavior. Social influence occurs when individuals try to adapt their attitudes, preferences, choices, and behaviors to those of others to conform to the interpretation of reality that appears to be shared by the group they belong to (or wish to belong to) and thereby simplifying the cognitive process of decision-making, to conform and identify with their social network avoiding feelings of isolation, and maintain consistency with their self-concept (Deutsch and Gerard, 1955; Cialdini and Goldstein, 2004; Abou-Zeid et al., 2013). The impact of social influence on travel choices, manifested through social norms, which are defined as the shared beliefs about the appropriate behavior in specific situations (Thøgersen, 2006), has been extensively analyzed in many past works. Previous research has demonstrated that social norms can influence various choices, such as the decision to purchase a car (Belgiawan et al., 2014; 2017; Vögle et al., 2021), the preference for alternative fuel vehicles (Barth et al., 2016; Cherchi, 2017; Kim et al., 2014; Saleem et al., 2021), the use of public transport (Bamberg et al., 2007; Zhang et al., 2016), and the adoption of active modes of transportation (Heinen et al., 2010).

Prompted by the evidence of an association between social norms and transportation choices, some studies have begun to explore the potential impact of implementing norm-based behavioral measures to reduce private car usage (Kormos et al., 2015; Riggs, 2017; Huber et al., 2018; Piras et al., 2021; Gravert & Collentine, 2021; Mundaca et al., 2022; Hauslbauer et al., 2022). While research in other domains such as energy use, recycling, and water conservation has shown promising results for social interventions (Farrow et al., 2017), there are still uncertainties about whether their adoption can lead to a shift in travel behavior away from cars towards more environmentally friendly alternatives.

One of the main challenges in generalizing the findings of much published research lies in the methodology used to assess the effectiveness of the measures. In some previous research (Riggs, 2017; Gravert & Collentine, 2021; Hauslbauer et al., 2022), the analysis was predominantly limited to descriptive statistics, and the authors did not isolate, by the construction of multivariate models, the effect of the social norm intervention from that of other variables, albeit they may play a role on travel behavior change. For instance, including in the analysis the Level of Service (LoS) variables, *e.g.,* travel time and cost, would permit to verify whether the effect of a norm message varies depending on the performance characteristics of the sustainable transport mode we aim to promote. At the same time, quantitatively assessing the different impacts of the norm intervention and the LoS variables would provide insights into the distinct role played by each factor in the process of travel behavior change, as well as permit to determine if a norm-based behavioral measure can match the effectiveness of a structural intervention that, for instance, reduces the travel time difference between the car and the transit alternatives.

Furthermore, in most prior studies, the analysis of the impact of experimental normative interventions on travel behavior change, even when conducted through the specification and estimation of multivariate models, did not explore the role of individuals' psycho-social characteristics (Kormos *et al*., 2015; Huber *et al*., 2018; Mundaca *et al*., 2022). These factors, which are frequently explored through the application of behavioral change theories such as the Theory of Planned Behavior (Ajzen, 1991), have been shown to explain much of the heterogeneity in individuals' choice decisions, especially when it comes to travel behaviors and mode choices (Choocharul & Fujii, 2007; Galdames *et al*., 2011; Hiscock *et al*., 2002). Although studies analyzing the impact of behavioral measures commonly neglect this set of variables (Piras *et al.*, 2022), we cannot disregard the fact that the effectiveness of a normative intervention may be hindered by individuals' psychological profile (Hauslbauer *et al.*, 2022). Let us consider the case of two different people, both car drivers, who receive a normative message informing them that commuting by public transit is a behavior approved of by their fellow citizens. Person A believes that the public transport service is unreliable and incompatible with his daily commitments (low level of Perceived Behavior Control), while person B finds using public transit for commuting relatively easy (high level of

Perceived Behavioral Control). It is likely that the persuasive messages would have a greater influence on person B compared to person A. The same rationale could be applied to other factors such as attitudes, perceived social norms, emotions, or environmental awareness.

In this study, we aim to quantitatively assess the effectiveness of different types of norm-based persuasive messages on the intention to commute by using a sustainable means of transport, controlling for the effect of travel and socioeconomic characteristics, as well as psycho-social factors. In our experiment, in addition to the normative message, each participant received a Personalized Travel Plan (PTP), which outlined a sustainable travel alternative (such as transit, cycling, or walking) for the home-to-work/study trip. The plan included a comparison of the suggested alternative with the car mode in terms of travel time, monetary cost, CO_2 emissions, and kilocalories burned. Data for this study were collected in the metropolitan area of Cagliari, Italy. From a methodological standpoint, we adopt an Integrated Choice and Latent Variable (ICLV) model (Vij & Walker, 2016) to jointly consider the effect of variables associated with the experiment, individual and household variables, and psychological factors.

The rest of the paper is structured as follows: in Section 2, we report a review of the literature investigating the effects of normative interventions on travel behavior change, and a summary of other persuasive strategies employed in Voluntary Travel Behavior Change (VTBC) programs. In Section 3 we briefly describe our experimental framework, including details about the sample characteristics and the psychometric measures employed. Section 4 outlines the modeling methodology utilized in the study, while in Section 5 we report and discuss modeling results. Finally, in Section 6 we draw the policy implications of our study, and in Section 8 we deliver the conclusions.

2. Literature review

In this section we describe we describe previous works that conducted experiments involving the implementation of persuasive normative measures, with a focus on the methods employed to quantify the effectiveness of these measures. Subsequently, we list and briefly describe other interventions that, along with normative messaging and the delivery of PTPs, can be applied in VTBC programs. Finally, the unique contributions of the present study are summarized.

2.1. Normative interventions on travel behavior change

Concerning the effectiveness of normative interventions as a tool to nudge people to change their travel behavior, past literature has presented mixed and controversial results. On one hand, earlier studies, such as the works by Kormos *et al*. (2015) and Riggs (2017), emphasized the positive effects of normative messages on reducing the use of the car. In contrast, more recent studies (Huber *et al*., 2018; Gravert and Collentine, 2021; Hauslbauer *et al*., 2022) found little to no effect of normative messages aimed at increasing public transport ridership and offsetting carbon emissions from car usage. Additionally, it has been argued that the normative messages' effectiveness could depend on the type of message delivered. Two recent studies (Piras *et al*., 2021; Mundaca *et al*., 2022) comparing descriptive and injunctive norm messages found that the latter is more effective in promoting sustainable mobility.

Previous works also differ in terms of the methodologies used to assess the effectiveness of normative measures. Some studies conducted on-field experiments, in which one or more normative interventions were delivered to groups of participants, and their impact was measured by comparing participants' actual behavior (Kormos *et al*., 2015; Riggs, 2017; Huber *et al*., 2018; Gravert & Collentine, 2021). Other past works, instead, set online or laboratory experiments, wherein individuals were exposed to various types of normative interventions, and their impact was assessed by asking participants about their intention to change their current travel behavior (Piras *et al*., 2021; Mundaca *et al*., 2022; Hauslbauer *et al*., 2022). Most often, such interventions consisted of a descriptive normative message that conveyed how many peer individuals were performing the suggested behavior. However, as mentioned before, two recent studies (Piras *et al*., 2021; Mundaca *et al*., 2022) also tested the effects of injunctive normative messages that highlighted the importance of adopting such behaviors for fellow citizens and society as a whole.

Beyond research studies, nowadays there has been the implementation of some real projects, either small or big, that use the idea of normative interventions to steer behavior change. The most well-known examples are those in the fields of medicine and physical activity, which in the majority of cases reported a positive effect of normative messages, either injunctive or descriptive, included in smartphone applications to increase the number of walking steps or more in general active mobility (Patrick *et al.*, 2014; Harries *et al.*, 2016; Gosetto *et al.*, 2020; Haque *et al.*, 2022). Even if the results are not reported, some mainstream applications (*e.g.*, Nike Run Club[1], Healthy Virtuoso[2], *etc.*) employ normative persuasive techniques in their applications to nudge users to walk and do more physical exercise. Also, in the field of route choice and navigation applications we can find some projects that employed normative messages (Ben-Elia and Avineri, 2015). For example, Guo *et al.* (2022), from the results of a survey conducted among a sample of users of the PokemonGo application, suggest the use of normative messages to nudge a route choice change. Nevertheless, they speak in general about normative intervention but do not distinguish between injunctive and descriptive interventions. Recently, Mayr *et al.* (2023) indicated that people are more likely to follow a route recommendation when it includes real-time congestion information and a persuasive message referring to social identity. One notable example of persuasive normative messaging to support behavioral change in the context of a trip planner smartphone application is Optimum by Anagnostopoulou *et al*. (2020). In their experimental study, the authors found that persuasive messages had some effect on individuals' route choice in approximately 40% of cases (Anagnostopoulou *et al*., 2020). Another field where persuasive messages could be adopted to nudge toward the adoption of more sustainable travel alternatives is that of Mobility as a Service, as suggested by Pangbourne *et al.* (2020) and Schikofsky *et al.* (2020). Nevertheless, from a review made by the authors on some of the most important projects concerning the design of MaaS apps (Moovit, IMove, BipForMaas, Maa4EU, Shift2MaaS), these projects seem not to implement a system

[1] https://www.nike.com/nrc-app
[2] https://healthyvirtuoso.com/it/

of normative persuasive mechanisms or do not share the results in a rigorous manner, making it difficult to discern the effect of the persuasive tool from that of other elements (*e.g.*, integrated ticket). In the field of research, there seems to be the same trend. The partial exception is the work of Merlin *et al.* (2022), which illustrates the methodology for the use of descriptive methods to encourage the use of MaaS in university settings, but they also do not provide any results of their tests.

In terms of methods used to estimate the impact of normative measures, previous works can be categorized into two groups. Due to the nature of the data, some studies conducted simple descriptive analyses without considering the influence of potential confounding factors on the results (Riggs, 2017; Gravert & Collentine, 2021; Hauslbauer et al., 2022). On the other hand, other studies employed statistical models that allowed for controlling the effects of multiple factors. The model structures employed include ANCOVAs (Kormos et al., 2015), Multinomial Logistic Regressions (Huber et al., 2018; Mundaca et al., 2022), and ICLV models (Piras et al., 2021).

Regarding the variables included in the model specifications, earlier works only incorporated objective variables such as baseline behavior and socioeconomic characteristics (Kormos et al., 2015; Huber et al., 2018) but neglected potential psychosocial factors that could influence individuals' decision-making processes. Consequently, more recent studies attempted to account for these aspects by including personal psychological traits. For example, Mundaca et al. (2022) considered the perception of the environmental impacts of car sharing and the perceived complementarity between car sharing and other forms of sustainable mobility. However, it is unclear how the authors constructed such psychological variables. In contrast, Piras et al. (2021) estimated three ICLV models that encompassed the following latent constructs: attitude toward public transport, environmental concern, and values.

2.2. Persuasive strategies for VTBC

Persuasive normative interventions and Personalized Travel Plans represent two of the various types of soft measures that have been applied in recent years within the context of Voluntary Travel

Behavior Change (VTBC) programs. These programs aim to encourage lasting shifts in travel behavior through the voluntary commitment of individuals, as opposed to relying on external directives that might lose their impact once removed.

Following the principles of persuasion outlined by Cialdini in his pioneering work (Cialdini, 2001), numerous interventions aimed at influencing the adoption of mobility habits that prioritize public transportation and active mobility have emerged. In their literature review, Anagnostopoulou *et al*. (2018) identify and describe several persuasive interventions. According to the authors, the most relevant and commonly applied strategies include:

- Social Comparison (*e.g*., normative interventions): people are more likely to be influenced to engage in the target behavior when their actions are compared to those of their peers.
- Tailoring (*e.g*., PTPs): the pieces of information used to persuade individuals are customized to their specific needs, personality, and usage context.
- Goal Setting: individuals are encouraged to change their behavior by comparing their current situation with a more desirable future outcome.
- Self-monitoring: with the use of persuasive technologies, individuals can track their own performance and status, aiding the process of behavioral change.
- Gamification: this strategy employs tactics such as rankings and rewards to incentivize behavioral change.

The effectiveness of these soft interventions is widely acknowledged in most of past works, particularly when a high degree of customization is involved. This customization encompasses socioeconomic and demographic characteristics, as different strategies may have varying impacts based on factors such as gender or age (Orji *et al*., 2015; Pangbourne *et al*., 2020). Similarly, personality traits may play a significant role, as diverse individual characters and attitudes may respond differently to persuasive strategies (Anagnostopoulou *et al*., 2017). Moreover, personal mobility traits may also influence effectiveness, with individuals who have previously explored alternative mobility behaviors and are willing to reduce their car usage being more receptive to these strategies (Anagnostopoulou *et al.*, 2017; Sunio *et al.*, 2017).

2.3. Contributions of the current study

Compared to prior studies that focused on exploring behavioral change theories in the context of social norms, often employing the measurement of items and structural equation models to evaluate the significance of these constructs as predictors of mobility and travel behaviors, our current research takes a different approach. We aim to empirically investigate the potential impact of persuasive messages, whose content is grounded in social norms, on influencing the intention to change travel behavior through a field experiment.

Given the wide variability in results observed in previous works that also attempted to nudge travel behavioral changes using normative messaging (see Section 2.1), it remains unclear whether persuasive normative interventions can be considered a valuable tool to steer a travel behavior change. To provide new insights to this discussion, the present works diverges from previous experimental studies in four essential ways.

First, we adopted an innovative experimental framework where each participant received a Personalized Travel Plan along with the normative message. The plan contained information about the most suitable sustainable travel alternative for their home-to-work/study trip. In this way it was possible to measure the effect of the message specifically on the intention to choose between the car and the proposed alternative and get a deeper knowledge on how the impact of the message may vary depending on the Level of Service characteristics of the sustainable means of transport being promoted. Furthermore, because different types of norms exist (Cialdini *et al.*, 1990), we compared the effectiveness of two different normative messages: descriptive and injunctive (**Appendix A**). According to Cialdini *et al*. (1990), descriptive norms refer to what most others do in a specific situation, whereas injunctive norms refer to what others approve or disapprove of.

Second, in addition to analyzing the two types of normative messages individually, the impact of the combination of these two statements (descriptive + injunctive) has been tested as well. Since the effect of combining different types of normative intervention remains an open debate (De Groot *et al*., 2013; Farrow *et al*., 2017; Smith *et al*., 2012), our objective was to determine whether the synergistic combination of these seemingly complementary and mutually confirmative messages could enhance the overall effectiveness of the measure.

Third, unlike much of prior research, we examined the results of our experiment by adopting a multivariate analysis, namely the construction of an Integrated Choice and Latent Variable (ICLV) model. This model formulation allowed us to investigate the different impacts of both observed characteristics and latent factors on the probability that individuals would express their intention to change travel behavior. In addition to the impact of the normative intervention, we analyzed the effects of feedback differences between the car and the suggested sustainable alternative (travel time, cost, CO_2 emissions, and kilocalories burned), decision-makers' socioeconomic characteristics, and their psycho-social latent constructs. The latent variables included in the study mainly followed the Theory of Planned Behavior (Ajzen, 1991). An innovative contribution of the present study lies in the computation of the pseudo-elasticity effects, which enabled us to quantitatively compare the impact of the normative measure with that of other explanatory variables. The framework of the ICLV model permits to quantify whether a variation of the psycho-social variable, introduced through a change in the value of one of the socio-demographic variables associated with the latent variable, is comparable to the impact of the normative measure. To the best of our knowledge, we are among the first to investigate this aspect in the field of persuasive messages.

Fourth, instead of mixing commuting and non-commuting trips, we decided to narrow our analysis solely to the impact of persuasive messages on commuting trips. This approach acknowledges that the same persuasive normative message may have different effects depending on the purpose of the trip (Kormos *et al*., 2015), and not accounting for this could introduce spurious effects that compromise the reliability of the experiment. While we are aware that examining both commuting and non-commuting trips could provide a clearer insight into the effect of normative messages, such an analysis would have required an experimental approach different from the one adopted in the current paper. Furthermore, normative interventions might prove to be more effective in the context of commuting trips, as found by Kormos *et al.* (2015). These interventions could act as a trigger for breaking the habit of using a car to reach the workplace or school, potentially resulting in a spill-over effect where this behavioral change extends to other trip purposes.

3. Data collection

3.1. Survey description

The present analysis uses data from the Voluntary Travel Behavior Change program our research group conducted to promote the use of pro-environmental means of transport in the city of Cagliari (Italy). The data collection process for this study involved a panel survey that encompassed three main steps (Figure 1).

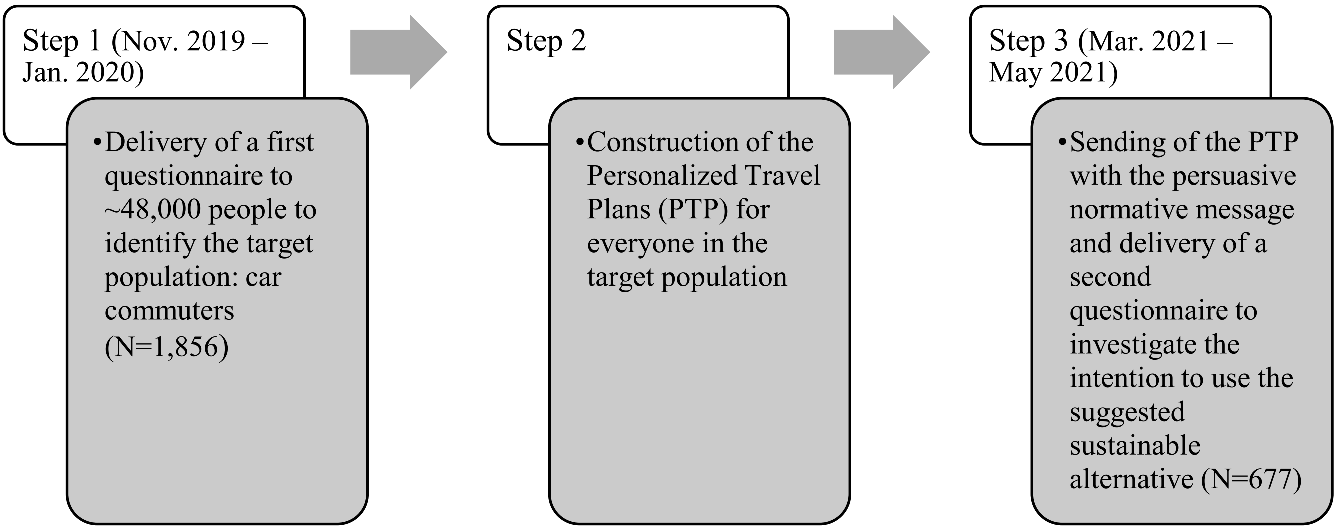

Figure 1 The steps of the experiment.

In the first step, conducted between November 2019 and January 2020, we reached potential participants for the experiment among workers and students within the metropolitan area of Cagliari. We employed various communication channels, such as a mass communication campaign, a social media campaign, and mailing lists of employees of the Regional administration of Sardinia and the municipality of Cagliari, teaching staff and students at the University of Cagliari. Participants were invited to complete an online questionnaire to gather information about their current travel behavior, socioeconomic characteristics, and psycho-social attributes. Based on the questionnaire responses, we identified the target population for our experiment: individuals who stated to commute by car (1,856 individuals).

In the second step, we constructed a Personalized Travel Plan (PTP) for the home-to-work/study trip of all the 1,856 individuals in the target population (see **Appendix B** for an example of a Personalized Travel Plan). The PTP recommended the most suitable sustainable modal alternative in terms of sustainability: walking, cycling, and public transport. We decided to suggest only one sustainable alternative for two main reasons:

- most participants had access to only one alternative and this procedure ensured that all the sample could choose between car and one sustainable means of transport;
- there was a possibility that the normative message had an effect only on the intention to use the first suggested travel alternative.

The assignment of the three sustainable alternatives followed specific rules outlined in Table 1. Despite the maximum bearable travel distances and slopes can vary based on personal characteristics such as age and fitness level, it was necessary to establish threshold values to determine the sustainable mode to suggest. Reference values were determined through the analysis of active travel behaviors obtained from the initial survey (Step 1 of Figure 1). Most walking commutes covered distances of up to 2 km, while cycling trips covered up to 5 km. These values align with existing literature, which suggests accessible walking commutes of around 2.5 km (Keijer & Rietveld, 2000; Chillón *et al*., 2016) and comfortable cycling commute distances of around 5 km (Hansen & Nielsen, 2014; Nordengen *et al*., 2019; Banerjee *et al*., 2022). In terms of average cycling slope, the threshold value of 2.5% also finds corroboration in existing literature (Broach *et al*., 2012; Wysling & Purves, 2022).

Table 1 Conditions to assign each of the sustainable modal alternatives.

Walking	• trip length under 2 km • path safely walkable
Cycling	• trip length between 2 km and 5 km • average slope under 2.5% • path suitable for cycling • possession of a bike
Public transport	• all the other cases

Next, we computed the following feedback for both the car and the sustainable alternative on a weekly and monthly basis: journey time, monetary cost, CO_2 emissions, and calories burned. The feedback associated with each travel alternative was estimated using Google Maps APIs, the cost per kilometer provided by the *Automobile Club Italia* (ACI)[3], the emission factors per unit kilometer suggested by the *Department of Environment* (DEFRA) of the UK[4], and relevant literature references for calculating calories burned during walking (Van der Walt & Wyndham, 1973) and cycling (Ainsworth *et al.*, 2011).

As a result, the suggested sustainable alternative was public transport for 80.1% of the sample, walking was proposed to 9.5% of the participants, and the remaining 10.4% were suggested to cycle. It should not be surprising that most participants were suggested using the transit alternative, given the territorial and transportation context in which the experiment took place. Indeed, many home-to-work/study trips generated in this area originate in the suburbs and head to the central city of Cagliari, exceeding the 2 km threshold (Table 1). Additionally, the use of bicycles is discouraged by the uneven topography of the area and, in many cases, the shortage of cycling infrastructures.

After building a Personalized Travel Plan for each participant, we randomly assigned them to one of the normative interventions tested in our experiment. Two types of normative messages have been tested: descriptive and injunctive (see **Appendix A**). The breakdown of participants was as

[3]https://www.aci.it/i-servizi/servizi-online/costi-chilometrici.html
[4]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/726911/2018_methodology_paper_FINAL_v01-00.pdf

follows: 464 participants were delivered with the descriptive normative message, 464 with the injunctive one, 464 with the combined descriptive + injunctive statement, and 464 were assigned to the control group (no persuasive normative message). To mitigate potential self-selection bias arising from the uneven distribution of individuals' characteristics among the various treatment groups and the control group, we conducted the random assignment process ensuring an even distribution of the proposed means of transport for each group. After collecting responses, an analysis of consistency in terms of socioeconomic factors between the treatment and control groups has been conducted, showing no appreciable differences among the different groups. The composition of each normative group in terms of socio-demographic characteristics is reported in **Appendix C**. In the third and final step, we delivered the Personalized Travel Plan alongside the persuasive normative message. Participants were asked to state their intention, right after reading the message, to either stick with their current behavior or choose to use the suggested alternative mode of transportation. This phase of the experiment was conducted between March and May 2021. Given the wide temporal extension of the experiment, we also provided participants with the option to choose none of the two proposed alternatives, due to, for instance, changes in their workplace or residential location.

The authors wish to emphasize that in the current study, we assessed individuals' stated preferences regarding their intention to change travel behavior. However, it is important to note that these preferences may not always translate into real-life choices, possibly influenced by factors such as cognitive dissonance (De Vos & Singleton, 2020) and social desirability bias (Grimm, 2010). Nevertheless, it is worth noting that intention has been proven to be a predecessor of actual behavior in behavioral theories and applications (Ajzen, 1991), and that previous research has identified strong associations between perceived and actual effectiveness of persuasive messages (Dillard *et al*., 2007).

As a result of the data collection, 677 individuals responded to the third phase, resulting in a response rate of 36.5%. However, 100 respondents did not choose either of the two alternatives. The final sample is, therefore, composed of 577 valid observations. Concerning the proportion of each suggested sustainable alternative within each normative group, a reasonably consistent distribution in the final data set is maintained, as shown in **Appendix C**. Specifically, the average share of individuals suggested to use public transport across norm groups is 80.1%, with a standard deviation of 0.4%. Meanwhile, the average proportions for walking and cycling are 9.3% (with a standard deviation of 1.8%) and 10.6% (with a standard deviation of 1.6%), respectively.

3.2. Sample description

The analysis of our final sample's characteristics is reported in Table 2. The distribution of the sample across gender is relatively even, with 49.6% males and 50.4% females. The average age of the individuals is 43.12 years, with a standard deviation of 11.75. More than half of the participants (55.3%) fall into the 41-60 age group. Since all participants reported commuting by car, each household had at least one available vehicle. On average, there were 1.88 cars per household, with a standard deviation of 0.74. In terms of residential location, approximately half of the sample resides within the municipality of Cagliari, 35.4% in the metropolitan area, and 14.5% in other parts of the Sardinian region.

Because of the attrition effect, there were slight changes in the distribution of participants across the normative message categories. Out of the 577 final respondents, 127 belonged to the descriptive normative message group, 143 to the injunctive one, 160 to the combined one, and 147 to the control group.

Table 2 Sample description.

Variables	**N**	**%**	**Avg.**	**S.D.**
Total	577	100	-	-
Gender				
Male	286	49.6	-	-
Female	291	50.4	-	-
Age	577	-	43.12	11.75
18 – 30	116	20.1	-	-
31 – 40	112	19.4	-	-
41 – 60	319	55.3	-	-
Over 60	30	5.2	-	-
Educational level				
At least a bachelor's degree	355	61.5	-	-
No degree	222	38.5	-	-
Personal monthly income				
< 1,000 €	117	20.3	-	-

Variables	N	%	Avg.	S.D.
1,001 – 1,500 €	159	27.5	-	-
1,501 – 2,000 €	173	30.0	-	-
> 2,000 €	128	22.2	-	-
Work condition				
Student	100	17.3	-	-
Not student	477	82.7	-	-
Number of cars per household	577	-	1.88	0.74
1	163	28.2	-	-
2	330	57.2	-	-
More than 2	84	14.6	-	-
Household composition	577	-	2.88	1.32
No children under 10 y/o	451	78.2	-	-
At least a child under 10 y/o	126	21.8	-	-
Residential location				
City of Cagliari	289	50.1	-	-
Cagliari metropolitan area	204	35.4	-	-
Rest of Sardinian region	84	14.5	-	-
Norm group				
Descriptive norm	127	22.0	-	-
Injunctive norm	143	24.7	-	-
Descriptive + injunctive norm	160	27.8	-	-
Control group	147	25.5	-	-

3.3. Psychometric measures

An inductive scale development approach was adopted to generate the items underpinning the individuals' psycho-social constructs of the study. The most suitable items were selected based on an extensive review of existing literature and were derived from an expanded framework of the Theory of Planned Behavior (Ajzen, 1991). The following latent constructs were considered: attitude toward sustainable mobility, perceived social norm, perceived behavioral control, environmental awareness, emotions. Each item was measured by means of a 5-point Likert scale.

Attitude toward sustainable mobility has been measured by asking how much participants felt "useful", "pleasant", and "right" using sustainable modal alternatives. Adapted from Fornara *et al.* (2016), the perceived social norm was measured by asking participants the extent to which their peers (friends, relatives, neighbors) made use of sustainable mobility and how much they perceived its usage as important. Perceived behavioral control, adapted from Klöckner and Friedrichsmeier (2011) and Bamberg *et al.* (2007), was assessed by gauging participants' perception of how easy it was for them to use sustainable mobility. Instead, environmental awareness was quantified by asking participants about their consciousness regarding the impact of cars on the environment and personal health and, adapted from Bamberg *et al.* (2003), about their perceived responsibility for the negative impacts of their choices. Finally, emotions toward sustainable mobility, adapted from Carrus *et al.* (2008), encompassed items related to participants' feelings of guilt, pride, or indifference when using a car instead of sustainable modal alternatives. Table 3 displays the distribution of these items in the entire sample of 577 participants.

Table 3 Distribution of the latent variables' measurement items (N=577).

Factor	Items	Avg.	1	2	3	4	5
LV1 Attitude toward sustainable mobility	ATT1: I find that using sustainable means of transport instead of the private car is useful.	3.84	6.4%	10.1%	13.0%	34.3%	36.2%
	ATT2: I find that using sustainable means of transport instead of the private car is pleasant.	3.44	11.1%	14.0%	20.8%	28.1%	26.0%
	ATT3: I find that using sustainable means of transport instead of the private car is right.	4.11	3.1%	3.6%	15.6%	34.8%	42.8%
LV2 Perceived social norm	SN1: Most of the people I know think I should use sustainable means of transport instead of the car.	2.36	29.8%	23.2%	32.6%	9.9%	4.5%
	SN2: Most of the people I know use sustainable means of transport instead of the car.	1.94	40.9%	36.0%	14.6%	5.5%	2.9%
LV3 Perceived Behavioural Control	PBC1: It would be easy for me to use sustainable means of transport.	2.07	41.1%	31.4%	12.0%	10.9%	4.7%
	PBC2: I am sure that in the next week I can use sustainable means of transport.	2.04	44.5%	25.8%	14.2%	12.0%	3.5%
	PBC3: For me using sustainable means of transport is possible.	2.73	20.3%	29.3%	21.7%	14.2%	14.6%
LV4 Environmental awareness	ENV1: I am aware that the use of private car has negative impacts on the environment and people's health.	4.31	0.9%	2.8%	7.3%	43.0%	46.1%
	ENV2: I am aware that I can personally contribute (by using the car less) to reducing pollution.	4.15	2.9%	3.5%	10.4%	41.9%	41.2%
	ENV3: I feel personally responsible for the environmental problems resulting from the choice of my means of transport.	3.32	10.6%	13.7%	22.2%	40.6%	13.0%
	ENV4: I feel personally responsible for the problems resulting from road congestion, space occupancy and car accidents in my city.	2.94	18.0%	19.8%	21.7%	31.4%	9.2%
LV5 Emotions	EM1: If during the next two weeks I will use the car instead of sustainable means of transport, I think I would feel guilty.	2.30	34.8%	21.8%	25.3%	14.7%	3.3%
	EM2: If during the next two weeks I will use sustainable means of transport instead of the car, I think I would feel proud.	3.47	12.1%	8.7%	20.3%	38.3%	20.6%
	EM3: If during the next two weeks I will use the car instead of sustainable means of transport, I think I would not feel indifferent.	3.09	15.9%	21.0%	31.5%	18.9%	12.7%

4. Methodology

4.1. The ICLV model

To quantify the effects of the normative intervention while accounting for feedback comparisons, individuals' socioeconomic characteristics, and latent constructs, we specified and estimated an ICLV model (Vij & Walker, 2016). This model simultaneously estimates a discrete choice model, in which the choices of the decision-makers are simulated as a function of observed and latent characteristics, assuming utility maximization, and a structural equation model, which estimates the value of the latent variables for each individual.

Following the usual framework of ICLV models, the latent variable *n* for individual *q* can be specified as (structural equation):

$$LV_{nq} = \kappa_n + \boldsymbol{\lambda}_n \boldsymbol{SE}_q + \omega_{nq}, \;\; \omega_{nq} \sim \mathcal{N}(0, \sigma_\omega) \tag{1}$$

where κ_n is a constant, $\boldsymbol{SE}_q$ is the vector of exogenous variables, $\boldsymbol{\lambda}_n$ is a vector of coefficients to be estimated, and $\boldsymbol{\omega}_q$ is an error term assumed to follow a normal distribution $\sim\mathcal{N}(0, \sigma_\omega)$. As proposed by Bolduc *et al*. (2005), the constant κ_n and the variance of the error term σ_ω have been normalized respectively to 0 and 1 for identification purposes.

Next, let *r (1, 2, ..., R)* be the index associated to each of the items I_{qr} we reported in Table 3. Let *m (1, 2, ..., M)* be the index for the ordered frequency categories of each item I_{qr}. Given the paucity of responses in the 4 and 5 categories for the items employed in the study, for identification purposes, we decided to collapse them into one category, so that *M = 4*. Then, the latent propensity I^*_{qr} associated to the *r-th* item (measurement equation) can be written as:

$$I^*_{qr} = \delta_r + \xi_r LV_{nq} + \upsilon_{rq}, \quad I_{qr} = m \; if \; \rho_{r,m-1} < I^*_{qr} < \rho_{r,m}, \; \rho_{r,0} = -\infty, \rho_{r,M} = \infty, \tag{2}$$

where δ_r is a constant, ξ_r is the loading of the latent variable LV_{iq}, and υ_{rq} is a logistic distributed error term. The $\boldsymbol{\rho}_r$ terms are the thresholds partitioning the latent propensity I^*_{qr} in *M* different segments. In order to ensure the increasing order of the thresholds, $\rho_{r,m}$ is defined as

$\rho_{r,m} = \rho_{r,m-1} + \delta_{r,m}$ where $\boldsymbol{\delta}_r$ are parameters to be estimated. Because of the logistic distribution of the error term υ_{rq}, each measurement equation takes the form of an ordered logit model. Note that the values of ξ_r can be positive or negative, and the sum of the loadings pertaining to each latent variable is not restricted to one (Daly *et al.*, 2012, Bhat and Dubey, 2014; Bhat, 2015).

Concerning the discrete part of the ICLV model, we specified a utility function for each of the three travel alternatives: car, public transport, and active mobility (walking and cycling). Because all the respondents could choose only between the car alternative and the suggested alternative, which was either public transport or active mobility, their availability for each means of transport was specified in the following way:

- the car alternative was available to all the respondents;
- the public transport alternative was available only to those who were suggested this travel option;
- the active mobility alternative was available only to those who were suggested this travel option.

Consequently, the general utility U_{jq} that each individual q associates with alternative j is specified as follows:

$$\Delta U_{jq} = V_{jq} + \varepsilon_{jq} = ASC_j + \sum_{k=1}^{4}\left(\beta_{j,k}^{N} + \boldsymbol{\beta}_{j,k}^{N,SE} \cdot \boldsymbol{SE}_q + \boldsymbol{\beta}_{j,k}^{N,LV} \cdot \boldsymbol{LV}_q\right) \cdot N_{k,q} + \beta_j^t \cdot \Delta time_{j,q} + \beta_j^c \cdot \Delta cost_{j,q}$$
$$+ \beta_j^{CO2} \cdot \Delta CO2_{j,q} + \beta_j^{kcal} \cdot \Delta kcal_{j,q} + \boldsymbol{\beta}_j^{SE} \cdot \boldsymbol{SE}_q + \boldsymbol{\beta}_j^{LV} \cdot \boldsymbol{LV}_q + \varepsilon_{jq},$$
$$\varepsilon_{jq} \sim Gumbel \qquad (4)$$

where,

ASC_j is the alternative specific constant;

$\beta_{j,k}^{N}$, $\boldsymbol{\beta}_{j,k}^{N,SE}$, $\boldsymbol{\beta}_{j,k}^{N,LV}$, β_j^t , β_j^c , β_j^{CO2} , β_j^{kcal} , $\boldsymbol{\beta}_j^{SE}$, $\boldsymbol{\beta}_j^{LV}$ are the vectors of coefficients associated with explanatory variables;

N_{kq} is a dummy variable that assumes the value of 1 for the normative message of type k, 0 vice versa;

$\Delta time_{j,q}$, $\Delta cost_{j,q}$, $\Delta CO2_{j,q}$, $\Delta kcal_{j,q}$ are the feedback variables;

$\boldsymbol{SE}_q$ is the vector of individual socioeconomic characteristics;

$\boldsymbol{LV}_q$ is the vector of latent variables;

ε_{jq} is the i.i.d. error term, following a Gumbel distribution (Extreme Value type 1).

Because of the assumption that the error term ε_{jq} is i.i.d. Gumbel distributed, the conditional likelihood for the decision-maker q can be calculated as:

$$P_q(\boldsymbol{y}_q|\boldsymbol{N}_q, \Delta time_{j,q}, \Delta cost_{j,q}, \Delta CO2_{j,q}, \Delta kcal_{j,q}, \boldsymbol{SE}_q, \boldsymbol{LV}_q) = \prod_j \left(\frac{exp(V_{jq})}{\sum_j exp(V_{jq})}\right)^{y_{qj}} \quad (5)$$

where $\boldsymbol{y}_q$ is the vector of observed choices of the individual q, so that $y_{q,j=1} = 1$ if individual q chooses alternative j, 0 vice versa.

The final conditional likelihood is:

$$LL_q\left(\boldsymbol{y}_q, \boldsymbol{I}_q \middle| \boldsymbol{SE}_q, \Delta time_q, \Delta cost_q, \Delta CO2_q, \Delta kcal_q\right) =$$

$$\int_{LV} P(\boldsymbol{y}_q|\boldsymbol{SE}_q, \Delta time_q, \Delta cost_q, \Delta CO2_q, \Delta kcal_q, \boldsymbol{LV}_q) \prod_r f\left(I_{rq}\middle|\boldsymbol{LV}_q\right) g\left(\boldsymbol{LV}_q\middle|\boldsymbol{SE}_q\right) d\boldsymbol{LV} \quad (6)$$

where f is the probability density function for the indicators and g is the probability density function of the latent variables. Because the solution to the integral in (6) does not have a closed form solution, numerical computational methods are employed to solve it (Hess *et al.*, 2006). We used the PandasBiogeme software (Bierlaire, 2020) to specify and estimate the model.

4.1.1. Specification of the effect of Personalized Travel Plan information

As mentioned earlier, in the Personalized Travel Plan we presented the following monthly feedback for both the car alternative and the suggested sustainable means of transport: travel time, travel cost, CO_2 emission savings, and kilocalories burned. To incorporate these feedback variables into the specification of the model, we computed the differences between the car alternative and the suggested alternative for each feedback variable. Then, we divided the sample into quartiles based on these differences. This means that each feedback variable included in the model's specification is represented by a vector of four dummy variables, with each dummy variable corresponding to one of the quartiles in which the sample was segmented. This segmentation procedure was employed to capture any potential non-linear effects of the feedback variables.

4.2. Pseudo-elasticity effects

One of objectives of the paper is to assess the relative importance and influence of the normative intervention compared to other factors. To do that, we estimate the aggregate-level "pseudo-elasticity effects" (Bhat *et al.*, 2017; Mondal and Bhat, 2022) for each independent variable included in the model specification:

$$\Delta P(y = j|\boldsymbol{x}, \widetilde{\boldsymbol{x}}) = \sum_{q=1}^{Q} \frac{1}{Q} \left[P\left(y_q = j|\widetilde{\boldsymbol{x}}_q\right) - P\left(y_q = j|\boldsymbol{x}_q\right)\right] \quad (7)$$

where

- $P\left(y_q = j|\boldsymbol{x}_q\right)$ is the current probability of choosing the alternative j
- $P\left(y_q = j|\widetilde{\boldsymbol{x}}_q\right)$ is the probability of choosing the alternative j following a treatment that modifies the value of the variable x_{qv} from A to B
- $\boldsymbol{x}_q$ is the vector of the observed data without any modification
- $\widetilde{\boldsymbol{x}}_q$ is the vector of the observed variables equal to $\boldsymbol{x}_q$ except for the variable x_{qv}, which has been modified
- Q is the number of individuals in the sample

Because the latent variables were defined as a function of socio-economic variables, we were able to compute the pseudo-elasticity effects due to a change in the value of the explanatory variables either in the discrete part of the model (direct effect) or in the latent variables (indirect effect).

5. Results

5.1. Overall

From the analysis of Table 4 it is clear that a large share of the sample (36.9%) expressed the intention to change their modal choice toward a more sustainable means of transport. However, we detected some differences in the intention to stop commuting by car depending on the sustainable travel alternative presented in the Personalized Travel Plan. 65.2% of those who were recommended active mobility (*i.e.*, walking or cycling) indicated their willingness to change, whereas the percentage dropped to 29.9% for those who were suggested public transport. The last outcome can be mainly attributed to the large difference, in terms of travel time, between the car and public transport (see Table D1 in **Appendix D**).

Concerning the effect of the normative messages, Table 4 shows that the injunctive norm group is the only one with a higher intention to use the suggested sustainable alternative (44.1%) compared to the control group (38.1%). This is particularly evident when the suggested alternative is public transport (39.1% compared to 30.5%), whereas for active mobility, there seems to be only a small difference. On the other hand, the combined message group presents lower intentions to change compared to those who did not receive any normative message (30.6% compared to 38.1%).

Table 4 Data analysis.

Suggested sustainable alternative	**Norm group**	**Choice**		**Total**
		Private vehicle	**Sustainable alternative**	
Active mode (N=115)	Descriptive norm	10 (38.5%)	16 (61.5%)	26 (100%)
	Injunctive norm	10 (35.7%)	18 (64.3%)	28 (100%)
	Descriptive + Injunctive norm	11 (34.4%)	21 (65.6%)	32 (100%)
	Control group	9 (31.0%)	20 (69.0%)	29 (100%)
	Total	40 (34.8%)	75 (65.2%)	115 (100%)
Public Transport (N=462)	Descriptive norm	72 (71.3%)	29 (28.7%)	101 (100%)
	Injunctive norm	70 (60.9%)	45 (39.1%)	115 (100%)
	Descriptive + Injunctive norm	100 (78.1%)	28 (21.9%)	128 (100%)
	Control group	82 (69.5%)	36 (30.5%)	118 (100%)
	Total	324 (70.1%)	138 (29.9%)	462 (100%)
Total (N=577)	Descriptive norm	82 (64.6%)	45 (35.4%)	127 (100%)
	Injunctive norm	80 (55.9%)	63 (44.1%)	143 (100%)

Descriptive + Injunctive norm	111 (69.4%)	49 (30.6%)	160 (100%)
Control group	91 (61.9%)	56 (38.1%)	147 (100%)
Total	364 (63.1%)	213 (36.9%)	577 (100%)

5.2. Factor analysis

We ran a confirmatory factor analysis to verify that the five latent constructs were effectively underlined by the items listed above. To examine the reliability of the factors, Cronbach's alpha was used. Table 5 shows the results of the confirmatory factor analysis. The analysis was performed using the software *SPSS*.

Despite the low value associated with Cronbach's alpha of the perceived social norm, we decided to include it in the model specification because it turned out to be a significant predictor of individuals' choice during the model estimation phase. We are aware that latent factors estimated with three or more items are more robust; however previous authors have demonstrated that having two items is a sufficient condition for identification (Bollen, 1989; Bhat, 2015).

Table 5 Confirmatory factor analysis.

Factor	Items	Loading	Cronbach's alpha
LV1 Attitude toward sustainable mobility	ATT1: I find that using sustainable means of transport instead of the private car is useful.	0.698	0.728
	ATT2: I find that using sustainable means of transport instead of the private car is pleasant.	0.653	
	ATT3: I find that using sustainable means of transport instead of the private car is right.	0.736	
LV2 Perceived social norm	SN1: Most of the people I know think I should use sustainable means of transport instead of the car.	0.579	0.500
	SN2: Most of the people I know use sustainable means of transport instead of the car.	0.579	
LV3 Perceived Behavioural Control	PBC1: It would be easy for me to use sustainable means of transport.	0.755	0.775
	PBC2: I am sure that in the next week I can use sustainable means of transport.	0.758	
	PBC3: For me using sustainable means of transport is possible.	0.691	
LV4 Environmental awareness	ENV1: I am aware that the use of private car has negative impacts on the environment and people's health.	0.606	0.762
	ENV2: I am aware that I can personally contribute (by using the car less) to reducing pollution.	0.709	
	ENV3: I feel personally responsible for the environmental problems resulting from the choice of my means of transport.	0.797	
	ENV4: I feel personally responsible for the problems resulting from road congestion, space occupancy and car accidents in my city.	0.606	
LV5 Emotions	EM1: If during the next two weeks I will use the car instead of sustainable means of transport, I think I would feel guilty.	0.688	0.665
	EM2: If during the next two weeks I will use sustainable means of transport instead of the car, I think I would feel proud.	0.653	
	EM3: If during the next two weeks I will use the car instead of sustainable means of transport, I think I would not feel indifferent.	0.558	

5.3. Model results

Model estimation results are displayed in Table 6. In the first block of Table 6 we report the coefficients of the discrete part of the model, while in the second block we show the results of the latent part of the model. The third block displays some goodness-of-fit measures. The results of the measurement equation models are shown in Table D2 in **Appendix D**.

5.3.1. Normative messages

Looking at the discrete part of the model, it emerges that receiving an injunctive normative message has a positive, but only marginally significant, effect on the intention to change from car to transit (t-stat 1.53). Conversely, the descriptive norm message has no effect. This finding is consistent with earlier research that found injunctive normative messages to be more effective than descriptive ones in persuading people to use sustainable mobility (Piras *et al.*, 2021; Mundaca *et al.*, 2022). There are two possible explanations for this result. On the one hand, the behavior shown in the descriptive normative message is actually adopted only by a small number of people in Cagliari, and the message could have lacked reliability, especially regarding the public transport alternative. On the other hand, the effectiveness of the descriptive normative message could have been hampered by a boomerang effect (Donald *et al*., 2014; Richter *et al*., 2018). In fact, according to Donald *et al.* (2014), people will be less likely to use a transport mode if they consider it to be overly congested. In the case of the current experiment, the fear of contracting the COVID-19 virus could have played a role in further inducing many individuals to avoid overcrowded places, such as buses and trams. Walking and cycling, on the other hand, were less affected by this concern, as active mobility was widely adopted in Italy during the COVID-19 pandemic, often at the expenses of public transit (Scorrano & Danielis, 2021).

With regards to the combination of the two normative statements, despite being complementary and mutually confirmative (Smith *et al.* 2012), it resulted in being counterproductive compared to the control group. This effect could be attributed to the excessive length of the message, making it unclear and difficult to interpret (Fogg, 2002).

On the other hand, the parameters associated to the delivery of the normative message, either descriptive, injunctive or a combination of the two, when included in the utility function of the active mobility alternative, turned out to be not statistically significant. Consequently, we decided to exclude them from the final model specification. This outcome suggests that knowing that other peer individuals have already shifted toward active mobility (descriptive message) or consider this a good behavior (injunctive message) does not affect the intention to commute by walking or cycling.

5.3.2. Personalized Travel Plan information

We now turn our attention to the effect on the Personalized Travel Plan information on those who were suggested the transit alternative. The only two feedback variables that were relevant from a statistically standpoint were those associated to the travel time and the calories burned. More specifically, if the difference, in terms of travel time, between the car and the suggested alternative is less than 11 hours per month[5] individuals are more likely to state their intention to use public transport. Similarly, an increase in the amount of calories burned larger than 2918.82 kcal per month[6] positively influences the intention to use public transport. While the first result supports evidence from prior research (Sanjust di Teulada *et al.*, 2014; Esztergár-Kiss *et al.*, 2021), the second one partially contradicts the findings of some previous works (Piras *et al.*, 2018; Sanjust di Teulada *et al.*, 2014, Esztergár-Kiss *et al.*, 2021), which suggest that the information related to calories is one of the least important. It is worth noting that the estimated parameter of the feedback associated with monetary savings was not significant, despite travel cost being considered one of the most important factors in the process of travel behavior change.

Surprisingly, we did not observe any statistically significant effect of the variation in travel time, cost, carbon emissions, and calories burned on the intention to use the active mobility, so we removed them from the final model specification. This result could be explained by the low level of variability in the information presented in the PTP, a consequence of the small number of people who were offered the active mobility alternative and the limited range of commuting distances (0-5 km) for individuals in this group. The low level of variability resulted in large standard errors, leading to a low significance of the parameters.

5.3.3. Individual and household characteristics

Let us now consider the effect of individual and household characteristics. It resulted that receiving a monthly salary of more than 1,000 € negatively impacts the intention to use public transport, while having a bachelor's degree has a negative influence on the probability of commuting by both public transport and active mobility. Next, we found that, in line with previous research

[5] 11 hours/month is the first quartile of the distribution of travel time differences of those suggested to use public transit.
[6] 2918.82 kcal/month is the third quartile of the distribution of the values of kcal burned by those suggested to use public transit.

(Sanjust di Teulada *et al.*, 2014; Piras *et al.*, 2022), the probability of changing travel behavior decreases as the number of cars in the household increases. These findings could be attributed, in addition to flexibility and comfort reasons, also to the symbolic and affective value that individuals often attribute to private cars (Steg *et al*., 2001; Lois & López-Sáez, 2009). Moreover, as outlined by Ashmore *et al.* (2019), in countries like Italy where hierarchy and differences between social classes are accepted (Nikolic *et al.*, 2020), the symbolic value attributed to public transport prevents wealthier people from using it, especially when it is a bus-based system like that of Cagliari. Lastly, we found that people living in the city of Cagliari are more inclined to state their intention to use active mobility, mainly due to their shorter commuting distances compared to those living in the suburbs. Additionally, the presence of more sidewalks and cycle paths within the city could have played a role in choosing this alternative.

The analysis of the interaction terms between the variable associated with the normative intervention and the other variables allowed us to detect possible differences in the effectiveness of the message depending on decision-makers' characteristics. Notably, after testing all the possible combinations, we observed a higher effectiveness of the injunctive norm message for individuals with a monthly income higher than 1,000€ who were suggested to use the transit alternative. In contrast with previous studies (Orji *et* al., 2015; Trelohan, 2022), we did not find any difference in the effectiveness of the normative message depending on the individuals' gender and age.

5.3.4. Psycho-social variables

One of the most important contributions of this study is the analysis of the effectiveness of the normative intervention while also controlling for decision-makers' psycho-social variables. Consistent with the findings of Donald *et al*. (2014), greater perceived behavioral control increases the intention to change towards greener mobility, both public transport and active mobility. As found by previous studies, such as Bamberg *et al*. (2007) and Zhang *et al*. (2016), the intention to use public transport is significantly affected by how much decision-makers perceive social norms. Indeed, the positive sign associated with this factor highlights how the use of public transport is affected by what significant others do or think. Attitude and environmental awareness were found to have a positive impact only on the willingness to adopt active mobility, while they resulted not relevant, from a statistical standpoint, when included in the utility function of the public transport.

We also tested the presence of interaction effects between the persuasive message and the latent variables. Interestingly, we found that the effect of the normative intervention, when the public transport alternative is suggested, is greater for individuals characterized by a higher level of perceived behavioral control and, therefore, find it easier to commute by using sustainable means of transport.

5.3.5. Latent part of the model

Consistently with previous research on environmental concern (Dietz *et al*., 2002; Xiao & McCright, 2007, 2014, 2015), we observed that women have a more positive attitude toward sustainable mobility and higher environmental awareness compared to men. Conversely, individuals with a higher number of cars per household exhibited a less favorable attitude toward sustainable mobility and lower levels of environmental awareness. People with more cars per household could have a worse attitude toward sustainable mobility and could be less concerned about the negative consequences of car usage because of the social status attributed to private cars (Steg *et al*., 2001; Lois & López-Sáez, 2009) and public transport (Ashmore *et al.*, 2019). Surprisingly, students appeared to have a less positive attitude toward sustainable mobility compared to workers. Indeed, it is generally believed that young people are more involved in pro-environmental behaviors and climate activism (Trelohan, 2022). However, the inclusion, in this experiment, of only students who usually commute by car could provide a possible explanation for this counterintuitive outcome.

Modeling results show that people with at least one child under 10 years old and those who have at least a bachelor's degree perceive social norms as less important. This can be explained by the fact that individuals with children may be less susceptible to peer pressure when it comes to modal choice because of the complex trip chaining involved in accommodating children's needs. This hypothesis could also explain the negative impact that the presence of children has on the perceived behavioral control toward sustainable mobility (Piras *et al*., 2022).

Both perceived social norms and perceived behavioral control are positively influenced by living in the city of Cagliari. In the case of the perceived social norms, this can be due to the provincial norm (Goldstein *et al*., 2008), which states that people get influenced by other individuals when they share the same living settings. Instead, the positive influence of this variable on the perceived behavioral control can be explained by the greater level of accessibility to sustainable means of transport and the presence of a more extensive public transport network in the main city.

Finally, having a monthly personal income of less than 1,000 € has a positive impact on both the social norm and the perceived behavioral control constructs. One possible explanation is that the majority of individuals in this income category are students or young people, who are predisposed to be more influenced by social norms (Foulkes *et al.*, 2017) and have more recent experience with the public transport alternative.

5.3.6. Goodness-of-fit measures

The goodness-of-fit measures indicate that our final model (unrestricted model) performs better than the model that includes only the variables associated with the persuasive normative messages (restricted model). The run of a Likelihood Ratio (LR) test (Horowitz, 1982) comparing the final log likelihood of the discrete part of the final model and the final log likelihood of the model including only the effect of the message gives the following result:

$$LR = -2\{l * (\vartheta_{res}) - l * (\vartheta) \} = 46.41 > \chi^2_{r=15} = 25.00\ (\alpha = 5\%) \tag{8}$$

Since the LR value is greater than the reference value of the Chi-squared distribution with $r = 15$ degrees of freedom (the difference in the number of estimated parameters between the restricted and unrestricted models) and a significance level $\alpha = 5\%$, the unrestricted model can be preferred to the restricted one.

Table 6 Model results.

Discrete part of the model		**Public transport**		**Active mobility**	
Explanatory variables		*Value*	*t-test*	*Value*	*t-test*
Alternative specific constant (Car is the base)		-0.83	-1.90 *	1.49	-1.28**
Effect of the normative message	Descriptive norm message (control group is the base)	-0.09	-0.25**	-	-
	Injunctive norm message (control group is the base)	0.60	1.53*	-	-
	Descriptive + Injunctive norm message (control group is the base)	-0.32	-0.94**	-	-
Feedback comparisons	Travel time increase < 11 hours/month (Yes = 1; No = 0)	0.59	-1.95 *	-	-
	Increase in kcal burned > 2918.82 kcal/month (Yes = 1; No = 0)	0.69	-2.25**	-	-
Socio-economic factors	Graduate (Yes = 1; No = 0)	-0.33	-1.29**	-1.66	-2.22**
	Personal monthly income under 1,000 € (Yes = 1; No = 0)	1.01	-2.57**	-	-
	Residential location inside Cagliari (Yes = 1; No = 0)	-	-	1.50	-1.66 *
	Number of cars per household	-0.33	-1.93 *	-0.61	-1.90 *
Effect of the latent variables	LV1 Attitude toward sustainable mobility	-	-	0.69	-1.66 *
	LV2 Perceived social norm	0.74	-3.53**	-	-
	LV3 Perceived behavioral control	0.52	-2.68**	0.81	-2.65**
	LV4 Environmental awareness	-	-	0.55	-1.65 *
Interaction factors	Injunctive message * Personal monthly income under 1,000 €	-1.60	-2.29**	-	-
	Injunctive message * LV3 Perceived behavioral control	0.94	-1.90 *	-	-
Latent part of the model					
Latent variables	Explanatory variables	Value		t-test	
LV1 Attitude toward sustainable mobility	Gender (Male = 1; Female = 0)	-0.16		-1.34**	
	Student (Yes = 1; No = 0)	-0.76		-4.52**	
	Number of cars per household	-0.12		-1.78 *	
LV2 Perceived social norm	At least a child < 10 y/o in the household (Yes = 1; No = 0)	-0.37		-2.56**	
	Graduate (Yes = 1; No = 0)	-0.20		-1.51**	
	Personal monthly income under 1,000 € (Yes = 1; No = 0)	0.45		-1.97**	
	Residential location inside Cagliari (Yes = 1; No = 0)	0.39		-2.63**	
LV3 Perceived behavioral control	At least a child < 10 y/o in the household (Yes = 1; No = 0)	-0.31		-2.44**	
	Graduate (Yes = 1; No = 0)	-0.14		-1.34**	
	Personal monthly income under 1,000 € (Yes = 1; No = 0)	0.34		-2.76**	
	Residential location inside Cagliari (Yes = 1; No = 0)	0.47		-4.85**	
LV4 Environmental awareness	Gender (Male = 1; Female = 0)	-0.22		-2.19**	
	Number of cars per household	-0.10		-1.64**	
Goodness-of-fit measures					
Number of estimated parameters				81	
Sample size				577	
Number of draws				1,000	
Final log likelihood				-6997.05	
Final log likelihood of the discrete part of the model				-328.45	
ρ^2 adj. of the discrete part of the model				0.144	
Final log likelihood of the model with only normative message variables				-351.65	
ρ^2 adj. of the model with only normative message variables				0.108	

Note: ** = significant with a probability ≥ 95%. * = significant with a probability ≥ 90%

5.4. Pseudo-elasticity effects

Table 7 presents the results of the computation of the pseudo-elasticity effects for each independent variable. These numbers may be interpreted as the increase or decrease in the probability of choosing alternative j due to a change in an independent variable.

Concerning the normative messages, if all participants had received an injunctive normative message, the average probability of declaring the intention to use the car would have decreased by 6.54%. On the other hand, if all participants had received a combined normative message (descriptive + injunctive), there would have been a counterproductive effect of reducing the intention of using public transport by 4.13%. The pseudo-elasticity value of the injunctive norm intervention is comparable to the one associated with the difference in travel time. Indeed, if all individuals had experienced a decrease or an increase in travel time of less than 11 hours per month, the choice probability associated with the car alternative would have decreased by approximately 5.67%.

Furthermore, non-neglectable of pseudo-elasticity effects are observed for the feedback related to calories (a 6.73% increase in the probability of declaring to prefer public transport if the suggested alternative involved a difference in calorie consumption larger than 2918.82 kcal per month) and personal income (a 13.83% increase in the choice probability of preferring public transport if individuals perceived a monthly income of less than 1,000€). Other socio-economic characteristics that have a considerable negative impact on the probability of choosing to use sustainable mobility are the educational level and the number of available cars in the household.

The analysis of the pseudo-elasticity effects also allowed us to distinguish between the direct and indirect (exerted through the latent variables) impacts of individuals' socioeconomic characteristics on choice probabilities. Results highlight a significant influence of personal income, household composition, and residential location variables on the intention to use public transport through the perceived behavioral control and environmental awareness constructs, with values comparable to the normative interventions. Concerning active mobility, being a student partially reduces the intention to use active mobility through the attitude construct, while living outside Cagliari reduces it through the perceived behavioral control factor.

Table 7 Pseudo-elasticity effects.

Independent variables	Change in the independent variable	Dependent variable	Total effect	Direct effect	Effect on LV1	Effect on LV2	Effect on LV3	Effect on LV4
Norm message	All individuals receive an injunctive message	Car	-6.54%	-6.54%	-	-	-	-
		Public Transport	+6.55%	+6.55%	-	-	-	-
		Active mobility	-	-	-	-	-	-
	All individuals receive a combined message	Car	+4.13%	+4.13%	-	-	-	-
		Public Transport	-4.13%	-4.13%	-	-	-	-
		Active mobility	-	-	-	-	-	-
	No individual receives any norm message	Car	+0.15%	+0.15%	-	-	-	-
		Public Transport	-0.14%	-0.14%	-	-	-	-
		Active mobility	-	-	-	-	-	-
Travel time	All ind. Have a decrease/increase <11 hours/month	Car	-5.67%	-5.67%	-	-	-	-
		Public Transport	+5.68%	+5.68%	-	-	-	-
		Active mobility	-	-	-	-	-	-
	All ind. Have an increase > 11 hours/month	Car	+2.00%	+2.00%	-	-	-	-
		Public Transport	-1.98%	-1.98%	-	-	-	-
		Active mobility	-	-	-	-	-	-
kcal burned	All ind. Have an increase > 2918.82 kcal/month	Car	-6.73%	-6.73%	-	-	-	-
		Public Transport	+6.73%	+6.73%	-	-	-	-
		Active mobility	-	-	-	-	-	-
	All ind. Have an increase < 2918.82 kcal/month	Car	+2.21%	+2.21%	-	-	-	-
		Public Transport	-2.20%	-2.20%	-	-	-	-
		Active mobility	-	-	-	-	-	-
Personal monthly income	All individuals perceive more than 1,000 € per month	Car	+3.62%	+1.75%	-	-	+1.03%	+1.08%
		Public Transport	-3.46%	-1.75%	-	-	-0.86%	-1.06%
		Active mobility	-0.16%	-	-	-	-0.16%	-
	All individuals perceive less than 1,000 € per month	Car	-14.59%	-7.17%	-	-	-3.12%	-3.19%
		Public Transport	+13.83%	+7.19%	-	-	+2.38%	+3.20%
		Active mobility	+0.76%	-	-	-	+0.74%	-
Graduate	All individuals have at least a bachelor's degree	Car	+4.82%	+3.44%	-	-	+0.70%	+0.82%
		Public Transport	-3.13%	-1.86%	-	-	-0.60%	-0.81%
		Active mobility	-1.69%	-1.58%	-	-	-0.10%	-
	No individual has at least a bachelor's degree	Car	-8.36%	-6.24%	-	-	-0.96%	-0.98%
		Public Transport	+4.29%	+2.38%	-	-	+0.69%	+0.98%
		Active mobility	+4.07%	+3.86%	-	-	+0.27%	-
Residential location	All individuals live within Cagliari	Car	-5.26%	-0.34%	-	-	-2.66%	-2.10%
		Public Transport	+4.80%	-	-	-	+2.56%	+2.09%
		Active mobility	+0.47%	+0.38	-	-	+0.10%	-
	All individuals live out of Cagliari	Car	+9.04%	+4.78%	-	-	+3.06%	+1.54%
		Public Transport	-3.25%	-	-	-	-1.84%	-1.53%
		Active mobility	-5.79%	-4.76%	-	-	-1.21%	-
Number of cars	Number of cars per household + 1	Car	+6.58%	+6.09%	+0.32%	+0.24%	-	-
		Public Transport	-3.98%	-3.98%	-	-	-	-
		Active mobility	-2.61%	-2.11%	-0.28%	-0.21%	-	-
	Number of cars per household -1	Car	-6.71%	-6.27%	-0.23%	-0.16%	-	-
		Public Transport	+4.28%	+4.28%	-	-	-	-
		Active mobility	+2.43%	+1.99%	+0.29%	+0.18%	-	-
Gender	All individuals are males	Car	+0.42%	-	+0.24%	+0.23%	-	-
		Public Transport	-	-	-	-	-	-
		Active mobility	-0.38%	-	-0.19%	-0.19%	-	-
		Car	-0.39%	-	-0.17%	-0.18%	-	-

Independent variables	Change in the independent variable	Dependent variable	Total effect	Direct effect	Effect on LV1	Effect on LV2	Effect on LV3	Effect on LV4
	All individuals are female	Public Transport	-	-	-	-	-	-
		Active mobility	+0.40%	-	+0.18%	+0.21%	-	-
Work condition	All individuals are student	Car	+1.59%	-	+1.59%	-	-	-
		Public Transport	-	-	-	-	-	-
		Active mobility	-1.55%	-	-1.55%	-	-	-
	No individual is a student	Car	-0.18%	-	-0.18%	-	-	-
		Public Transport	-	-	-	-	-	-
		Active mobility	+0.23%	-	+0.23%	-	-	-
Children under 10 y/o	All individuals have at least a child < 10y/o	Car	+5.61%	-	-	-	+3.03%	+2.72%
		Public Transport	-4.95%	-	-	-	-2.38%	-2.72%
		Active mobility	-0.66%	-	-	-	-0.66%	-
	All individuals do not have any child < 10y/o	Car	-1.37%	-	-	-	-0.69%	-0.58%
		Public Transport	+1.17%	-	-	-	+0.48%	+0.57%
		Active mobility	+0.21%	-	-	-	+0.21%	-

6. Policy implications

The findings described above have a number of important implications for transport planners and policymakers aiming to promote the usage of sustainable means of transport in urban areas.

First, when implementing normative measures to encourage the use of public transport, the focus should be on injunctive messages, which resulted to be the most effective in our study. Importantly, because the impact of the injunctive message was observed to be similar to that of the travel time, it seems that the implementation of such soft measures, which require relatively small financial investments, can be as effective as the development of an infrastructural measure that necessitates substantial funding, at least to the measure in which participants' stated intentions translate into actual behavior. This type of persuasive strategy could also be employed to promote Mobility as a Service, as suggested by some works (Pangbourne et al., 2020; Schikofsky et al., 2020), given that the backbone of such a system is public transport. At the same time, given the scarcity of studies about MaaS and persuasive normative messages, more research is needed to confirm the efficacy of injunctive messages in nudging the adoption of Mobility as a Service on a large scale.

Second, the finding that the injunctive message is more effective among people with a higher level of perceived behavioral control emphasizes once more the importance of integrating both infrastructural and behavioral measures. If city administrations want to obtain the maximum impact from the implementation of a normative measure, they should enable and facilitate public transport usage, and this can be done only with measures aimed at improving the level of service, reliability, and comfort of transit.

Third, we observed that the combination of injunctive and descriptive messages did not yield any positive effect, but rather led to a decrease in the probability of changing travel behavior, possibly due to its excessive length. This result confirms that the information delivered through a persuasive message should be easily acquired, as well as useful, usable, and used.

Fourth, when promoting active mobility, it is important to recognize that relying solely on social norm-based messages may not be sufficient to drive a change in travel behavior. At the same time, a high percentage (65.2%) of people who were proposed to use the active mobility expressed their intention to change their travel behavior, suggesting that the Personalized Travel Plan alone can be a valid promotional tool for this modal alternative, probably because of the better trade-offs between gaining (reduced cost) and losses (increased travel times) compared to public transport. To further convince people to choose cycling or walking, other types of messages should be employed, which could be based on those psycho-social factors that our study pointed out to be relevant in the process of taking up commuting by bike or walking, namely the attitude toward sustainable mobility and the environmental awareness. Moreover, previous studies analyzing tailored persuasive messages to promote walking, as in the trial tests and apps reviewed in the introduction, have shown that health-related arguments have a significant impact on encouraging walking habits (Pangbourne *et al*., 2020). Circling back to the discussion of alternative persuasive techniques for promoting sustainable travel behavior as proposed in Section 2.2, past literature has recognized effective strategies for promoting walking and cycling in goal setting, self-monitoring, and gamification (Doğru *et al*., 2021; Harris & Crone, 2021; Weber *et al*., 2018).

7. Limitations and future developments

This research does have some limitations that should be acknowledged. First and foremost, this study exclusively examined individuals' intentions to use sustainable means of transport, rather than their actual behavior. However, it is important to note that this approach is a common practice in studies that evaluate persuasive interventions, and it is worth mentioning that previous authors have found strong evidence of an association between the perceived and actual effectiveness of these strategies (Dillard *et al.*, 2007). Furthermore, our sample is not representative of the entire population of the metropolitan area of Cagliari, as it mainly consisted of university students and public employees who participated in our experiment. Another potential limitation stems from the attrition effect in responses, resulting in a less-than-ideal balance among groups regarding socio-demographic characteristics, although the imbalance is not substantial. Moreover, people who participated in the last part of the experiment could be more prone to behavioral change because of their willingness to participate in the project, leading to a possible overestimation of the effectiveness of the norm message intervention. Finally, when considering practical applications, some might argue that Personalized Travel Plans could face scalability issues due to the lengthy and time-consuming process required for tailoring them to each participant. However, advances in technology and automation may offer solutions to streamline the personalization process and enhance scalability.

In the next step of our research, we aim to extend the analysis on a larger scale to verify whether our findings hold true when considering individuals with different characteristics. Moreover, we plan to monitor participants' behavior using a mobility management application, able to track in real-time trips and activities. Furthermore, as a potential future development for investigating the impact of Personalized Travel Plans on the intention to change travel behavior, it could be possible to explore how individuals evaluate the trade-offs, as postulated in prospect theory (Kahneman & Tversky, 2013), between potential losses in travel time and the benefits in terms of cost savings, reduced carbon emissions, and calories burned when transitioning to sustainable mobility. In this context, the prospect theory could prove to be a valuable tool.

Despite the limitations, we believe that our work has provided valuable insights in this field and the modeling methodology we proposed can contribute to improving predictions regarding the impact of interventions based on social norms.

8. Conclusions

In the current work, we modeled the influence of a persuasive normative intervention on the intention to commute by using a sustainable travel alternative instead of the car. This objective was motivated by the lack of evidence regarding the effectiveness of normative messages in inducing a travel behavior change, as much published research investigating this topic has yielded inconclusive or inconsistent findings. Moreover, only a few works have developed predictive models able to encompass all the possible variables, objective and subjective, which could have interfered with the results. To fill this gap, we constructed an Integrated Choice and Latent Variable model, with which we were able to assess not only the impact of different types of normative messages and the benefits of using sustainable modes of transport, but also the influence of participants' socio-economic and psycho-social characteristics. The data required to estimate the model were obtained from a Voluntary Travel Behavior Change program we conducted among a sample of car commuters working in Cagliari (Italy).

Overall, our results show that individuals who were suggested to commute using active mobility (walking or cycling) were more likely to state their intention to change their travel behavior compared to those who were proposed to use public transport. In terms of the effect of the message, our model results confirmed that injunctive normative messages had a greater influence in reducing the intention to use the car compared to messages based on other types of norms (descriptive or descriptive + injunctive). When both types of normative interventions were presented together, they had a counterproductive effect: individuals who received both messages actually showed reduced willingness to decrease their private car usage. However, our analysis revealed that the injunctive message only had a persuasive effect on public transport, while had no effect on the active mobility.

Interestingly, from the computation of pseudo-elasticity effects, it turned out that the injunctive norm message could have increased the probability of choosing public transport to a similar extent as if all individuals experienced a limited daily travel time gap between car and public transit.

The second contribution of the study was to understand the role played by the psychological factors in the context of persuasive normative messages. Our findings support the idea that the process of travel behavior change cannot be analyzed without taking into consideration people's psychological profiles. More importantly, the fact that the injunctive message was more effective for those people with a higher level of perceived behavioral control confirms that persuasive messages do not have the same impact on everyone, but they exert a different influence depending on individuals' characteristics.

In conclusion, our paper addressed some of the lacunae in research in normative interventions for commuting behavior change, although we are aware that some questions still remain to be answered. Only through further research and experiments, pushing the debate on the effectiveness of persuasive messaging in prompting a shift from car usage to more sustainable modes of transport, can we hope to gain a comprehensive understanding of these complex dynamics.

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Appendix A

Descriptive norm message: "Among Cagliari workers/students who, like you, use the car every day to go to their workplace/university, it has been ascertained that a significant part of them is changing their habits by choosing to use sustainable means of transport daily".

Injunctive norm message: "According to a recent survey carried out among Cagliari workers/students who, like you, use the car every day to go to their workplace/university, most of them would approve the choice of fellow citizens to use sustainable means of transport daily."

Appendix B

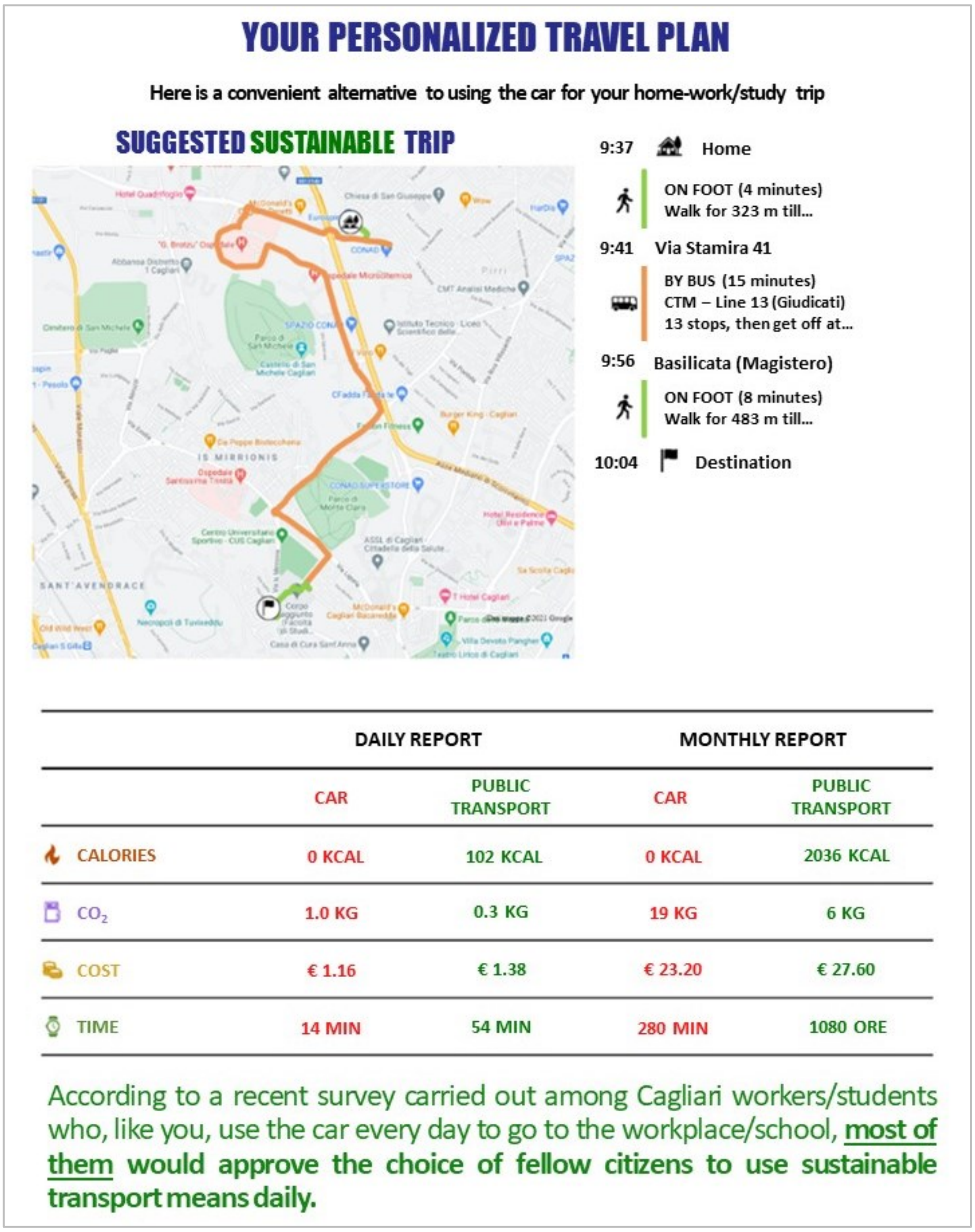

Figure 2 An example of PTP

Appendix C

Variables	Descriptive norm	Injunctive norm	Descriptive + injunctive norm	Control group
Total	127	143	160	147
Gender				
Male	51.2%	52.4%	51.3%	43.5%
Female	48.8%	47.6%	48.8%	56.5%
Age [AVG.]	41.08	42.06	44.58	43.27
Educational level				
At least a bachelor's degree	59.1%	56.6%	68.1%	61.2%
No degree	40.9%	43.4%	31.9%	38.8%
Personal monthly income				
< 1,000 €	20.5%	25.9%	14.4%	21.1%
1,001 – 1,500 €	23.6%	30.8%	24.4%	31.3%
1,501 – 2,000 €	28.3%	25.2%	41.3%	23.8%
> 2,000 €	27.6%	18.2%	20.0%	23.8%
Work condition				
Student	18.9%	21.0%	12.5%	16.3%
Not student	81.1%	79.0%	87.5%	83.7%
Household composition				
No children under 10 y/o	25.2%	21.7%	20.6%	18.4%
At least a child under 10 y/o	59.1%	56.6%	51.3%	56.5%
Residential location				
City of Cagliari	46.5%	51.0%	50.6%	51.7%
Cagliari metropolitan area	37.0%	31.5%	37.5%	35.4%
Rest of Sardinian region	16.5%	17.5%	11.9%	12.9%
Proposed alternative				
Public transport	79.5%	80.4%	80.0%	80.3%
Cycling	10.2%	12.6%	8.8%	10.9%
Walking	10.2%	7.0%	11.3%	8.8%

Appendix D

Table D1 Daily average comparison between the car and the suggested sustainable alternative

			Travel time [min/day]		Monetary cost [€/day]		CO_2 emitted [$kgCO_2$/day]		kcal burned [kcal/day]	
		N	**Avg.**	**S.D.**	**Avg.**	**S.D.**	**Avg.**	**S.D.**	**Avg.**	**S.D.**
Suggested sustainable alternative: Walking	Car	54	13.44	5.62	0.70	0.31	0.60	0.26	0	-
	Walking		37.96	11.40	0	-	0	-	192.36	63.21
Suggested sustainable alternative: Cycling	Car	61	19.51	5.07	1.40	0.54	1.18	0.45	0	-
	Cycling		26.85	6.31	0	-	0	-	206.53	56.29
Suggested sustainable alternative: Public transport	Car	462	38.84	22.87	4.78	4.99	4.15	4.38	0	-
	Public transport		88.28	43.27	2.29	1.73	1.77	2.48	117.71	82.78

Table D2 Results of indicators' measurement equation models

Measurement equation	*Value*	*t-test*
LV1 Attitude toward sustainable mobility		
Constant ATT1	4.64	9.25**
Constant ATT2	3.87	8.15**
Constant ATT3	5.77	8.18**
Coefficient ATT1	1.79	6.40**
Coefficient ATT2	1.81	6.50**
Coefficient ATT3	1.93	4.88**
Delta2 ATT1	1.37	7.61**
Delta2 ATT2	1.40	7.98**
Delta2 ATT3	1.03	4.74**
Delta3 ATT1	1.09	7.38**
Delta3 ATT2	1.42	8.68**
Delta3 ATT3	1.92	7.94**
LV2 Perceived social norm		
Constant SN1	1.10	4.78**
Constant SN2	0.37	2.22**
Coefficient SN1	1.49	3.23**
Coefficient SN2	1.22	3.81**
Delta2 SN1	1.40	6.16**
Delta2 SN2	2.05	8.51**
Delta3 SN1	2.32	6.59**
Delta3 SN2	1.42	7.55**
LV3 Perceived Behavioural Control		
Constant PBC1	0.28	1.03
Constant PBC2	0.01	0.03

Constant PBC3	1.91	7.81**
Coefficient PBC1	2.50	8.92**
Coefficient PBC2	3.09	6.90**
Coefficient PBC3	1.97	10.4**
Delta2 PBC1	2.58	10.6**
Delta2 PBC2	2.42	7.93**
Delta2 PBC3	2.27	12.2**
Delta3 PBC1	1.29	7.58**
Delta3 PBC2	1.81	7.10**
Delta3 PBC3	1.52	10.7**
LV4 Environmental awareness		
Constant ENV1	6.60	9.66**
Constant ENV2	6.00	8.33**
Constant ENV3	5.97	5.87**
Constant ENV4	3.00	8.35**
Coefficient ENV1	1.81	4.99**
Coefficient ENV2	2.24	5.92**
Coefficient ENV3	3.60	4.95**
Coefficient ENV4	1.99	9.27**
Delta2 ENV1	1.63	4.24**
Delta2 ENV2	1.10	5.02**
Delta2 ENV3	2.10	5.47**
Delta2 ENV4	1.56	9.99**
Delta3 ENV1	1.40	6.23**
Delta3 ENV2	1.55	6.89**
Delta3 ENV3	2.39	6.10**
Delta3 ENV4	1.45	10.50**

Note: ** = significant with a probability ≥ 95%. * = significant with a probability ≥ 90%