IATSS Research 48 (2024) 516–522

Contents lists available at ScienceDirect

IATSS Research

journal homepage: www.sciencedirect.com/journal/iatss-research

Research Article

Factors associated with speeding behavior of Moroccan drivers: Study guided by the theory of planned behavior

Abderrahim El Hafidy [a,*], Taoufik Rachad [a], Ali Idri [a,b]

[a] Software Project Management Research Team, ENSIAS, Mohammed V University in Rabat, Morocco
[b] Mohammed VI Polytechnic University, Ben Guerir, Morocco

ARTICLE INFO

Keywords:
Speeding behavior
Theory of planned behavior
Confirmatory factor analysis
Structural equation modeling
Road safety

ABSTRACT

This study investigates the determinants that influence drivers to exceed speed limits by using an extended version of the Theory of Planned Behavior (TPB). Therefore, data about 254 drivers representing various cities in Morocco were collected via a web-based questionnaire. Then, confirmatory factor analysis (CFA) was used to validate the proposed questionnaire, while structural equation modeling (SEM) was conducted to analyze and validate the hypothesized model. The results suggest that the extended TPB, incorporating additional factors of habit, moral norms and descriptive norms, outperforms the original TPB. Moreover, the findings underscore that speeding behavior is directly influenced by both speeding intention and habit, and indirectly influenced by moral norms and habit through the mediation of intention. The result of this study will contribute to developing new behavior change interventions aiming at combating speeding behavior and also contributing to ongoing efforts aiming at promoting road safety.

1. Introduction

For many decades, road crashes have represented a global concern for all countries due to their consequences for public health and safety. According to the World Health Organization (WHO), road crashes claim more than 1.19 million lives annually [1] and cause up to 50 million injuries [2]. Additionally, road traffic injuries stand as the primary cause of death among children and young adults aged between 5 and 29 years [1]. In Morocco, according to the national report about road safety, around 3600 people lose their lives each year because of road crashes, with 150,000 sustaining injuries annually [3].

Among the various causes of road crashes, human factors remain the leading cause of 90 % to 95 % of fatal crashes [4,5]. In addition, previous studies confirmed the strong correlation between road crashes and different aberrant driving behaviors especially for driving violations and driving errors [6]. Also, several studies identified speeding, drunk driving, non-use of helmets/seatbelts, and distracted driving (i.e., mobile phone use) as significant factors linked to numerous traffic fatalities [7–9]. However, speeding is recognized by several works as the primary cause of road crashes [10,11]. Therefore, we are currently focusing on identifying the main psychological determinants of speeding behavior.

Referring to behavioral science, several theories of behavior change are used to understand and explain many human behaviors. However, the Theory of Planned Behavior (TPB) [12] is the most used and cited [13,14]. Therefore, compared to existing theoretical models, TPB reveals exceptional accuracy in predicting individual behaviors, demonstrating higher predictability than other theories [15,16]. It comprises three constructs; attitude that concerns the overall evaluation of individuals to a particular behavior, including their positive or negative feelings and assessments, subjective norm that denotes an individual's perception of the social influence or pressure exerted on them to perform or not perform a specific behavior, and perceived behavioral control (PBC) that reflects individual's perception of their capability to execute a given behavior. Furthermore, TPB provides the flexibility to incorporate additional factors to enhance its applicability and predictive power [12,17]. This is desirable in behavior understanding to make adaptation of the theory to features of target behavior and target population to ultimately develop efficient behavior change interventions. Therefore, the main goal of this study is to identify the additional factors to be considered with standard TPB for the understanding of speeding behavior of Moroccan drivers.

Referring to prior meta-analysis about aberrant driving behaviors [18], descriptive norms, moral norms, and habit were the most important additional constructs of TPB. Descriptive norms refer to individuals'

* Corresponding author.
E-mail address: abderrahim_elhafidy@um5.ac.ma (A. El Hafidy).

https://doi.org/10.1016/j.iatssr.2024.09.003
Received 4 January 2024; Received in revised form 21 May 2024; Accepted 30 September 2024
Available online 25 October 2024

beliefs toward actions to be performed in a given situation according to what others usually do [20]. Moral norms reflect the perception of the correctness or incorrectness of performing a particular behavior, taking into account personal values and principles [21]. Habit, also known as past behavior [22], refers to the automatic processes that guide behaviors or activities that an individual has previously engaged in [23]. Subsequently, according to meta-analysis referenced above, it is suggested to consider descriptive norms, moral norms and habit as strong predictors of speeding intention, and moral norms and habit as strong predictors of speeding behavior. Moreover, the meta-analysis revealed a little impact of PBC on speeding behavior. Therefore, we present in Fig. 1 an extended version of TPB in which we consider the connections between additional constructs and speeding behavior and intention as hypotheses to be confirmed.

In order to validate the extended TPB model within the Moroccan context, we conduct a survey in the form of a questionnaire that will support drivers in self-reporting their speeding behavior by providing them with questions about all constructs of the extended TPB. Then, the collected data from the questionnaire will be fitted to the extended TPB model to know which hypothesized path in the model will be retained in the Moroccan context and to know also what the current data tell us about the relationships between different constructs.

The remainder of this paper will be organized as follows: Section 2 outlines the research methodology and materials, while Section 3 presents the study's results. Section 4 discusses the obtained results and offers suggestions for an effective behavior change intervention. Finally, Section 5 provides a general conclusion.

2. Method and materials

2.1. Participants

The methodology adopted in the present study is based on a questionnaire conducted in Morocco between April 1 and May 30, 2023. The questionnaire was available in Arabic and French, and it was disseminated through various online platforms, including Facebook, WhatsApp, and email. Subsequently, A total of 258 drivers participated in the questionnaire and that were assured of the voluntary and anonymous nature of their responses. However, it is essential to note that no institutional review board or other regulatory agency approved this research ethically.

During the period of data collection, we considered only fully completed questionnaires. Thus, 254 drivers completed the questionnaire successfully, demonstrating an effective response rate of 98.45 %, with 76.38 % male and 23.62 % female drivers, who had an average age of 36.05 years (S·D = 10.47 years). Most participants were single (50 %), 41 % were married, 6 % were divorced, and 4 % were widowed. Moreover, most drivers (66 %) reported having a university degree. Further details regarding the other characteristics of the sample are provided in Table 1.

2.2. Questionnaire design and validation

The questionnaire considered in this study was adapted from relevant literature to be aligned with the Moroccan context [21,24–32]. Therefore, the questionnaire comprises two main parts. The first part gathers demographic information about the drivers, including age, gender, education degree, and driving experience, while the second part assesses the drivers' psychological factors using an extended version of the TPB that incorporates attitude comprising five items, one of which was reverse coded, subjective norm with five reverse coded items, PBC with five items, three of which were reverse coded, descriptive norms comprising four items, moral norms measured using five reverse coded items, past behavior measured by using five items, speeding intention measured by one item, and finally behavior assessed by two items. Reverse coding were used to keep the same scale interpretation for all items. As presented in Table 2, all the items will be rated on a 5-point

Table 1
Demographic variables of the participants.

Variables	Group	Number	Percentage
Gender	Male	194	76.38 %
	Female	60	23.62 %
Marital status	Single	127	50 %
	Married	103	41 %
	Divorced	14	6 %
	Widowed	10	4 %
Education degree	University	167	66 %
	Secondary	64	25 %
	Intermediate	16	6 %
	Others (professional training…)	7	3 %
Age	[18–25]	43	17 %
	]25–35]	90	35 %
	]35–45]	75	30 %
	]45–55]	32	13 %
	]55–65]	14	6 %
Driving experience	Below 2 years	48	19 %
	From 2 to 5 years	44	17 %
	From 5 to 10 years	88	35 %
	More than 10 years	74	29 %

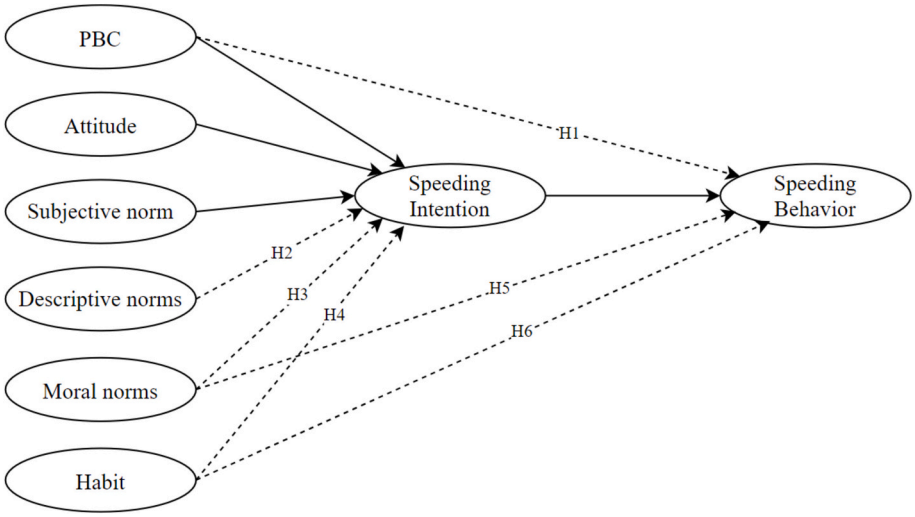

Fig. 1. Extended TPB with hypothesized paths between constructs.

Table 2
The questionnaire items.

Part 1: Demographic information			
Q 1: You are: (optional)	Q2: How old are you? (optional)	Q 3: What is your education degree? (optional)	Q 4: Your driving experience: (optional)
o man	o Under 20 years old	o Without	o less than 2 years
o woman	o 20 to 30 years old	o Primary	o between 2 and 5 years
	o 30 to 40 years old	o College	o more than 5 years
	o 40 to 50 years old	o Secondary	o I don't drive
	o Over 50 years old	o Superior	
		o Other (Quranic studies, training)	

Part 2: Psychological factors		
Items	Questions	5-point Likert scale
ATT (1)	For me, speeding improves self-confidence, and my feeling of independence	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
ATT (2)	For me, speeding is good or bad?	(1 = very bad, 2 = bad, 3 = Acceptable, 4 = good, 5 = very good)
ATT (3)	For me, speeding increases the risk of severe crashes (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
ATT (4)	For me, speeding makes you win time	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
ATT (5)	If I win time by speeding that would be	(1 = very bad, 2 = bad, 3 = Acceptable, 4 = good, 5 = very good)
PBC (1)	As long as I like, I can avoid speeding? (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
PBC (2)	I am confident that I can avoid speeding. (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
PBC (3)	For me, avoiding speeding, is:	(1 = Very difficult,2 = Difficult,3 = Neutral,4 = Easy,5 = Very easy)
PBC (4)	The condition of the road would affect my decision to speed	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
PBC (5)	I can respect the speed limit even when other drivers are speeding (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
SN(1)	My family members think that speed limits should be respected (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
SN(2)	My friends and acquaintances think that speed limits should be respected (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
SN(3)	Most people that are important to me think that speed limits should be respected (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
SN(4)	My passengers think that speed limits should be respected (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
SN(5)	I generally like to drive in the way that the police would approve of (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
PB(1)	How often have you exceeded the speed limit over the last 6 months?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
PB(2)	How often have you exceeded the speed limit when travelling alone?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
PB(3)	How often have you exceeded the speed limit on residential streets?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
PB(4)	Driving fast is something I do automatically	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
PB(5)	Driving fast is something I do all the time	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
MN (1)	If I exceeded the speed limit, I would regret it afterward (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
MN (2)	If I exceeded the speed limit, I would feel really bad (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
MN (3)	If I exceeded the speed limit, It would be wrong of me (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
MN (4)	Everyone should obey the speed limit because it is safe (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
MN (5)	I would favor stricter enforcement of the speed limit on all roads (reverse coded)	(1 = strongly disagree, 2 = disagree, 3 = Undecided, 4 = agree, 5 = strongly agree)
DN (1)	How often do your friends and acquaintances exceed the speed limit?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
DN (2)	How often does your family members exceed the speed limit?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
DN (3)	How often do most drivers exceed the speed limit?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
DN (4)	How often do people who are important to you exceed the speed limit?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
INT (1)	My intention to speeding in the future is	(1 = Very unlikely, 2 = Unlikely, 3 = Neutral, 4 = Likely, 5 = Very likely)
BH (1)	How many times in general do you exceed the speed limits?	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)
BH (2)	I exceed the speed limit on motorway	(1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Very Often, 5 = Always)

Likert scale; ranging from 1 (strongly disagree) to 5 (strongly agree).

To assess the validity of the proposed questionnaire, we performed a Confirmatory Factor Analysis (CFA) by examining the relationships between observed variables and their associated factors. Therefore, the initial version of the questionnaire did not achieve good fitting, something that pushed us to make changes in the questionnaire by considering returned modification indices. Therefore, the items ATT3, PBC4, PBC5 and SN5 were deleted because their factor loadings were less than 0.50, and some item errors were connected because of their strong correlation. Table 3 presents a comparison of the fitting indices of the initial and revised questionnaires, showing that the revised questionnaire is more consistent.

Table 3
Summary of fit indices.

Fit indices	Initial model	Revised model	Specification
Chi-square ($\chi 2$)	739.452	446.766	
df	437	320	
$\chi 2$/df	1.692	1.396	<3.000 as recommended in [33]
RMSEA	0.052	0.040	<0.080 as recommended in [34]
CFI	0.885	0.948	>0.90 as recommended in [35]
SRMR	0.0703	0.0538	<0.10 as recommended in [35]

Additionally, Table 4 presents the standardized factor loadings, means, standard deviations (SD), and reliabilities (Cronbach alpha) of both initial and revised models. The analysis indicates a reliability ranging between 0.632 and 0.848 for all factors in relation to their composite items, which is considered acceptable by the existing literature [36–39]. Subsequently, the revised questionnaire presented in Table 4 will be considered in the remainder of this work in order to address the study's objective.

3. Results

To assess the validity of the hypothesized TPB model, we applied Structural Equation Modeling (SEM) using AMOS software. Also, to ensure an appropriate sample size, we adhered to Soper's sample size calculator [40], which recommends a minimum sample size of 177 observations. Subsequently, our sample size of 254 participants exceeds this recommended minimum, which is deemed adequate for conducting SEM analysis. Moreover, in order to refine the model fit and evaluate the validity of the various hypothesized paths, we followed the methodological guidelines outlined in [41]. It consists of testing many combinations of hypothesized paths resulting in many alternative models. Specification search method provided by AMOS software [42] was used for the identification of the most appropriate alternative model. Therefore, from a total of 44 alternative models, the first 10 best are presented in Table 5. Subsequently, model 28 presented in Fig. 2 emerged as the most favorable, demonstrating the smallest BCC0, C/df ratio, *p*-value and RMSEA fit function criteria, as detailed in Table 5.

Table 6 shows the correlations between various constructs of the adopted TPB model presented in Fig. 2. It shows that speeding behavior is strongly correlated with speeding intention, and it is moderately correlated with habit, indicating that drivers having the intention and the habit to exceed the speed limit are more likely to engage in speeding behavior in the future, as evidenced by prior studies [24,43]. On the other hand, speeding intention is moderately correlated with moral norms, suggesting that drivers intending to exceed the speed limit often possess unfavorable (NB: code of moral norms items were reversed) normative values and principles, which is consistent with previous academic findings [21]. Additionally, habit is moderately correlated with subjective norm, indicating an association between drivers' habit of exceeding the speed limit and the social pressure exerted by their entourage, as demonstrated in previous studies [44]. Moreover, attitude and moral norms demonstrate a moderate correlation, reflecting an association between drivers' beliefs, ethical values, and principles, as supported by previous research [24]. Furthermore, moderate correlations were observed between PBC and attitude on one hand, and between PBC and subjective norms on the other hand. This underlines the significant association between the control of engaging in speeding behavior and the drivers' beliefs on one side and social pressure on the other side, as supported by prior studies [45].

Table 7 presents the standardized direct and indirect effects of all constructs on speeding behavior. Notably, both intention and habit exhibit significant direct effects on speeding behavior. Therefore, the speeding intention is the best predictor of speeding behavior, a result that is consistently confirmed by prior research underscoring its crucial role in predicting speeding behavior [21,43]. Then, habit comes in the second rank as a significant predictor affecting speeding behavior; this can be explained by the fact that drivers accustomed to exceeding speed limits in the past are likely to exceed speed in the future; this is confirmed by several studies that have identified habit among the strongest predictors of speeding behavior [29,44].

By considering the mediation of the intention for the prediction of speeding behavior, all constructs of standard TPB in addition to descriptive norms exhibited non-significant indirect effects. However, moral norms and habit showed a significant influence on speeding

Table 4
Factor loadings and reliability of TPB constructs.

	Initial model					Revised model				
Constructs	Items	Mean	SD	Factor loading	Reliability	Items	Mean	SD	Factor loading	Reliability
Attitude	ATT1	2.35	1.179	0.614	0.736	ATT1	2.35	1.179	0.660	**0.762↑**
	ATT2	2.02	1.023	0.698		ATT2	2.02	1.023	0.719	
	ATT3	1.70	0.896	0.361						
	ATT4	2.67	1.206	0.723		ATT4	2.67	1.206	0.658	
	ATT5	2.56	1.079	0.625		ATT5	2.56	1.079	0.543	
Subjective norm	SN1	1.67	0.684	0.668	0.742	SN1	1.67	0.684	0.669	**0.763↑**
	SN2	1.77	0.822	0.694		SN2	1.77	0.822	0.679	
	SN3	1.67	0.781	0.641		SN3	1.67	0.781	0.666	
	SN4	1.73	0.755	0.665		SN4	1.73	0.755	0.666	
	SN5	1.81	0.891	0.416						
PBC	PBC1	2.02	0.966	0.540	0.337	PBC1	2.02	0.966	0.544	**0.632↑**
	PBC2	1.93	0.942	0.617		PBC2	1.93	0.942	0.673	
	PBC3	2.21	0.994	0.623						
	PBC4	3.55	1.164	−0.183		PBC3	2.21	0.994	0.607	
	PBC5	2.02	0.962	0.436						
Descriptive norms	DN1	2.66	0.955	0.571	0.748	DN1	2.66	0.955	0.566	0.748
	DN2	2.36	0.854	0.721		DN2	2.36	0.854	0.724	
	DN3	2.91	0.990	0.633		DN3	2.91	0.990	0.630	
	DN4	2.35	0.805	0.727		DN4	2.35	0.805	0.729	
Moral norms	MN1	2.71	1.203	0.635	0.809	MN1	2.71	1.203	0.578	0.809
	MN2	2.59	1.131	0.675		MN2	2.59	1.131	0.621	
	MN3	2.49	1.040	0.821		MN3	2.49	1.040	0.854	
	MN4	2.55	1.023	0.728		MN4	2.55	1.023	0.736	
	MN5	1.89	1.006	0.539		MN5	1.89	1.006	0.532	
Habit	PB1	1.95	0.849	0.829	0.848	PB1	1.95	0.849	0.724	0.848
	PB2	1.86	0.858	0.778		PB2	1.86	0.858	0.657	
	PB3	1.74	0.806	0.699		PB3	1.74	0.806	0.741	
	PB4	2.07	0.951	0.693		PB4	2.07	0.951	0.749	
	PB5	1.96	0.908	0.632		PB5	1.96	0.908	0.698	
Speeding intention	INT1	2.20	1.06	1.000	NA	INT1	2.20	1.06	1.000	NA
Speeding behavior	BH1	2.03	0.809	0.808	0.808	BH1	2.03	0.809	0.842	0.808
	BH2	2.08	0.912	0.844		BH2	2.08	0.912	0.810	

Note: NA = Not Applicable.

Table 5
Summary of fit measures for the 10 best models sorted by BCC, C/df and p.

Model	Name	Params	df	C	C - df	AIC 0	BCC 0	BIC 0	C / df	p	RMSEA
28	Default model	109	325	450.172	125.172	0.000	**0.000**	2.835	**1.385**	**0.000**	**0.039**
18	Default model	108	326	452.875	126.875	0.703	0.444	**0.000**	1.389	**0.000**	**0.039**
38	Default model	110	324	449.422	125.422	1.249	1.508	7.621	1.387	**0.000**	**0.039**
29	Default model	109	325	452.125	127.125	1.953	1.953	4.787	1.391	**0.000**	**0.039**
39	Default model	110	324	450.172	126.172	2.000	2.259	8.372	1.389	**0.000**	**0.039**
30	Default model	109	325	452.874	127.874	2.702	2.702	5.536	1.393	**0.000**	**0.039**
19	Default model	108	326	455.284	129.284	3.112	2.853	2.409	1.397	**0.000**	0.040
44	Default model	111	323	449.347	126.347	3.175	3.692	13.084	1.391	**0.000**	**0.039**
40	Default model	110	324	452.060	128.060	3.887	4.146	10.259	1.395	**0.000**	0.040
31	Default model	109	325	454.609	129.609	4.436	4.436	7.271	1.399	**0.000**	0.040

Note: AIC = Akaike Information Criteria; BCC = Browne-Cudeck criterion; BIC = Bayes information criterion; C = chi-square; df = degrees of freedom; p = significance level; RMSEA = Root Mean Square Error of Approximation.

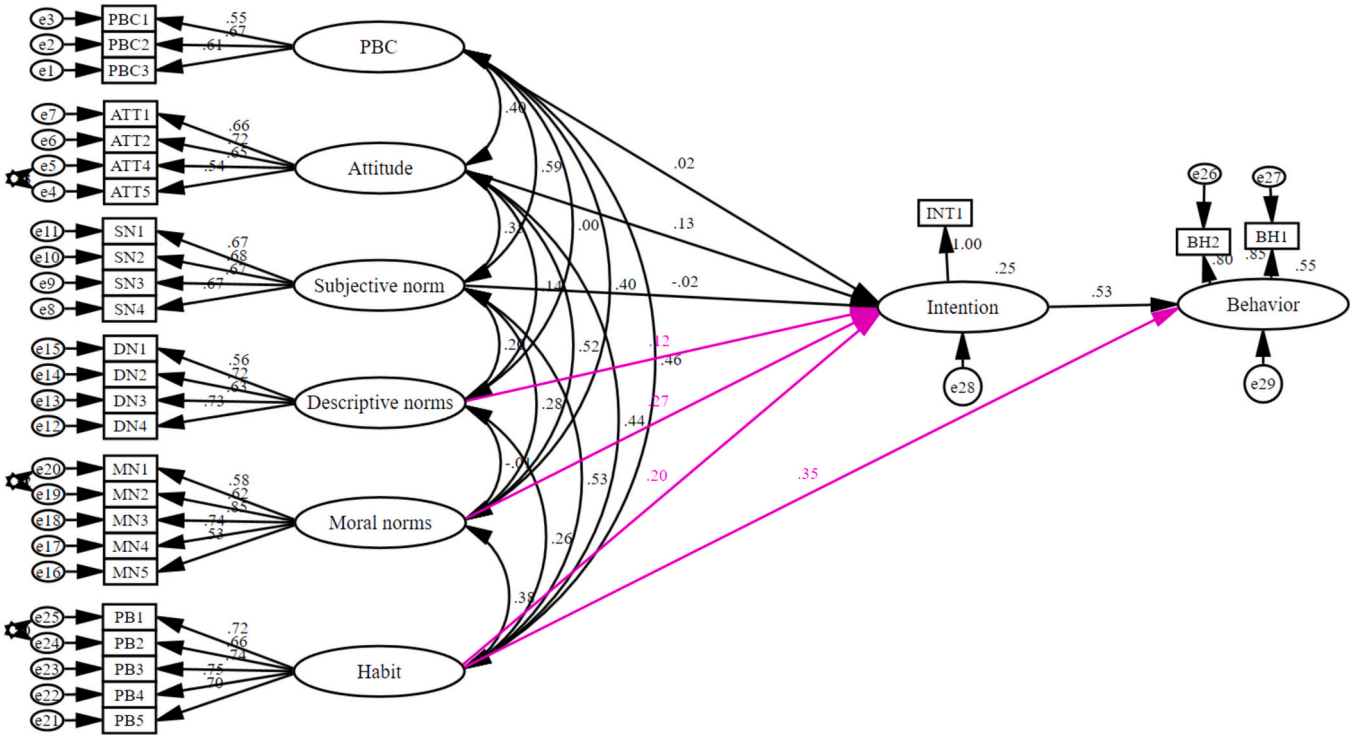

Fig. 2. The retained version the extended TPB model.

Table 6
Correlation between TPB constructs.

TPB Constructs	1	2	3	4	5	6	7	8
1. Attitude	1							
2. Subjective norm	0.348***	1						
3. PBC	0.403***	0.584***	1					
4. Descriptive norms	0.137	0.202*	0.003	1				
5. Moral norms	0.524***	0.279**	0.394***	−0.008	1			
6. Habit	0.431***	0.526***	0.455***	0.258**	0.383***	1		
7. Speeding Intention	0.370***	0.237**	0.256**	0.181*	0.410***	0.385***	1	
8. Speeding Behavior	0.389***	0.310***	0.358***	0.259**	0.351***	0.550***	0.668***	1

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

intention, indicating that these additional constructs play a fundamental role in shaping speeding intentions of Moroccan drivers. This result is consistent with previous research [24,26,46] that found habit and moral norms to significantly influence the intention toward speeding.

4. Discussion

The findings of this study indicate that speeding behavior is completely predicted by speeding intention and speeding habit. Other constructs influence speeding behavior indirectly by the mediation of speeding intention. Specifically, moral norms exhibited a significant indirect effect on speeding behavior. For other constructs, despite their

Table 7
The standardized effects of TPB constructs on speeding behavior.

Constructs	Direct effects	Indirect effects	Total effects	Type of mediation
Attitude	NA	0.068 (NS)	0.068 (NS)	Indirect-only mediation
SN	NA	−0.013 (NS)	−0.013 (NS)	Indirect-only mediation
PBC	NA	0.012 (NS)	0.012 (NS)	Indirect-only mediation
Descriptive norms	NA	0.062 (NS)	0.062 (NS)	Indirect-only mediation
Moral norms	NA	0.141 **	0.141 **	Indirect-only mediation
Habit	0.349 ***	0.107 *	0.456 ***	Complementary mediation
Intention	0.533 ***	NA	0.533 ***	Direct-only non-mediation

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, NA = Not Applicable, NS = Non-Significant.

non-significant effect on speeding behavior, they remain correlated with it, and they will be kept in the model, especially for the constructs of the original TPB, namely, attitude, subjective norm, and PBC. These findings confirm the fact that each target behavior and each target population have different features from others, and they will be studied using adapted versions of TPB by considering additional constructs that will expedite the understanding and explanation of the behavior.

Intention to exceed the speed limit has been considered in the original TPB model as the principal predictor of speeding behavior [12]. Also, several empirical studies have experimentally demonstrated that intention is the principal predictor of various human behaviors [47], thing that is also confirmed by the result of this study. Also, additional factors of habit and moral norms demonstrated a significant effect on speeding behavior. Therefore, the emergence of habit as a good predictor of speeding behavior and intention can be explained by the fact that drivers often consider exceeding the speed limit as mandatory, particularly in certain situations where there is necessity to quickly reach destinations due to time constraints [48]. Eventually, the habit of exceeding speed limit can result on the pressure applied by the entourage of family, friends or passengers that consider that exceeding the speed limit is desirable. This idea is supported by the fact that habit is strongly correlated by subjective norms. However, as depicted previously, moral norms have a significant direct effect on intention; this can be explained by the fact that normative values and principles induced from educational and religious characteristics of Moroccan society have a significant effect on drivers' decisions and actions.

Future works will focus on the design and development of behavior change interventions aiming at combating speeding behavior by addressing the constructs identified as significant in the Moroccan context. Specifically, designers of behavior change interventions will investigate behavior change techniques (BCTs) adapted to each construct in order make regulation of the behavior. Therefore, Michie et al. [49,50] have provided a mapping between the BCTs and the constructs derived from various theories. Also, many frameworks can guide the behavior change intervention (BCI) of which the most used are: Intervention Mapping [51], Behavior Change Wheel [52], the BASIC framework [53], and the EAST framework [54].

5. Conclusion

The present study aimed to investigate the determinants influencing drivers to exceed the speed limit using an extended TPB incorporating descriptive norms, moral norms, and habit. To systematically address the study's objective and validate the hypothesized TPB model within the Moroccan context, a web-based questionnaire was administered and validated through a confirmatory factor analysis (CFA), indicating the validity and reliability of the self-reported questionnaire. Furthermore, the hypothesized model was analyzed and validated using structural equation modeling (SEM), suggesting that speeding behavior is directly influenced by both speeding intention and habit, and indirectly influenced by all constructs, mainly, by moral norms and habit. The obtained results should be considered when developing appropriate interventions to address speeding issues and promote road safety.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Abderrahim El Hafidy: Conceptualization, Investigation, Methodology, Writing – original draft. **Taoufik Rachad:** Conceptualization, Methodology, Supervision, Validation, Writing – review & editing. **Ali Idri:** Validation.

Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, or publication of this article.

References

[1] Global Status Report on Road Safety 2023, World Health Organization, 2023.
[2] World Health Organization, Global Status Report on Road Safety 2018, World Health Organization, Geneva, 2018.
[3] NARSA, Accueil | Agence Nationale de la Sécurité Routière. https://www.narsa.ma/fr/accueil, 2023 (accessed July 23, 2023).
[4] S. Payani, H. Hamid, T. Hua Law, A review on impact of human factors on road safety with special focus on hazard perception and risk-taking among young drivers, IOP Conf. Ser. Earth Environ. Sci. 357 (2019), https://doi.org/10.1088/1755-1315/357/1/012041.
[5] S. Jomnonkwao, S. Uttra, V. Ratanavaraha, Analysis of a driving behavior measurement model using a modified driver behavior questionnaire encompassing texting, social media use, and drug and alcohol consumption, Transp. Res. Interdiscip. Perspect. 9 (2021) 100302, https://doi.org/10.1016/j.trip.2021.100302.
[6] T. Rachad, A. Elhafidy, A. Idri, Aberrant driving behavior and accident involvement: Morocco case study, Transp. Res. Rec. J. Transp. Res. Board 036119812211191 (2022), https://doi.org/10.1177/03611981221119184.
[7] C. Castanier, T. Deroche, T. Woodman, Theory of planned behaviour and road violations: the moderating influence of perceived behavioural control, Transp. Res. Part F Traffic Psychol. Behav. 18 (2013) 148–158, https://doi.org/10.1016/j.trf.2012.12.014.
[8] D. Parker, A.S.R. Manstead, S.G. Stradling, J.T. Reason, J.S. Baxter, Intention to commit driving violations: an application of the theory of planned behavior, J. Appl. Psychol. 77 (1992) 94–101, https://doi.org/10.1037/0021-9010.77.1.94.
[9] F. Lheureux, L. Auzoult, C. Charlois, S. Hardy-Massard, J.-P. Minary, Traffic offences: planned or habitual? Using the theory of planned behaviour and habit strength to explain frequency and magnitude of speeding and driving under the influence of alcohol, Br. J. Psychol. 107 (2016) 52–71, https://doi.org/10.1111/bjop.12122.
[10] T. Stewart, Overview of Motor Vehicle Crashes in 2020 (Report No. DOT HS 813 266), Natl. Highw. Traffic Saf. Adm. DOT HS 813 (2022) 1–43. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813060.
[11] A. El Hafidy, T. Rachad, Prediction of Speeding Intention Based on the Theory of Planned Behavior 2023, 2023, pp. 1–6, https://doi.org/10.1109/SITA60746.2023.10373749.
[12] I. Ajzen, The theory of planned behavior, Organ. Behav. Hum. Decis. Process. 50 (1991) 179–211, https://doi.org/10.1016/0749-5978(91)90020-T.
[13] T.M. Nguyen, P.T. Nham, V.N. Hoang, The theory of planned behavior and knowledge sharing: a systematic review and meta-analytic structural equation modelling, VINE J. Inf. Knowl. Manag. Syst. 49 (2019) 76–94, https://doi.org/10.1108/VJIKMS-10-2018-0086.
[14] R.D. Ledesma, J.D. Tosi, C.M. Diaz-Lazaro, F.M. Poo, Predicting road safety behavior with implicit attitudes and the theory of planned behavior, J. Saf. Res. 66 (2018) 187–194, https://doi.org/10.1016/j.jsr.2018.07.006.
[15] C.J. Armitage, M. Conner, Social cognition models and health behaviour: a structured review, Psychol. Health 15 (2000) 173–189, https://doi.org/10.1080/08870440008400299.
[16] K. Jiang, F. Ling, Z. Feng, K. Wang, C. Shao, Why do drivers continue driving while fatigued? An application of the theory of planned behaviour, Transp. Res. Part A Policy Pract. 98 (2017) 141–149, https://doi.org/10.1016/j.tra.2017.02.003.

[17] I. Ajzen, Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior, J. Appl. Soc. Psychol. 32 (2002) 665–683, https://doi.org/10.1111/j.1559-1816.2002.tb00236.x.
[18] A. El Hafidy, T. Rachad, A. Idri, Understanding aberrant driving intentions based on the Theory of Planned Behavior: Literature review and Meta-Analysis, J. Safety Res. 90 (2024) 225–243, https://doi.org/10.1016/j.jsr.2024.05.005.
[20] E. Rošková, E. Stopjaková, The Extended Theory of Planned Behavior in Context of Risky Driving – Speeding, 2015, pp. 179–186, https://doi.org/10.17758/erpub.e1115060.
[21] D. Jovanovic, M. Sraml, B. Matovi, An Examination of the Construct and Predictive Validity of the Self-reported Speeding Behavior Model 99, 2017, pp. 66–76, https://doi.org/10.1016/j.aap.2016.11.015.
[22] M. Conner, C.J. Armitage, Extending the theory of planned behavior: a review and avenues for further research, J. Appl. Soc. Psychol. 28 (1998) 1429–1464, https://doi.org/10.1111/j.1559-1816.1998.tb01685.x.
[23] L. Sommer, The theory of planned behaviour and the impact of past behaviour, Int. Bus. Econ. Res. J. 10 (2011) 91–110, https://doi.org/10.19030/iber.v10i1.930.
[24] P. De Pelsmacker, W. Janssens, The Effect of Norms, Attitudes and Habits on Speeding Behavior: Scale Development and Model Building and Estimation 39, 2007, pp. 6–15, https://doi.org/10.1016/j.aap.2006.05.011.
[25] M. Conner, N. Smith, B. McMillan, Examining normative pressure in the theory of planned behaviour: impact of gender and passengers on intentions to break the speed limit, Curr. Psychol. 22 (2003) 252–263, https://doi.org/10.1007/s12144-003-1020-8.
[26] M.A. Elliott, J.A. Thomson, The social cognitive determinants of offending drivers' speeding behaviour, Accid. Anal. Prev. 42 (2010) 1595–1605, https://doi.org/10.1016/j.aap.2010.03.018.
[27] L. Zhu, Z. Zhang, Z. Bao, Speeding behaviors in beijing based on the theory of planned behavior, in: ICTE 2011 - Proc. 3rd Int. Conf. Transp. Eng, 2011, pp. 547–554, https://doi.org/10.1061/41184(419)91.
[28] H. Paris, S. Van Den Broucke, Measuring Cognitive Determinants of Speeding: An Application of the Theory of Planned Behaviour 11, 2008, pp. 168–180, https://doi.org/10.1016/j.trf.2007.09.002.
[29] D.D. Dinh, H. Kubota, Speeding behavior on urban residential streets with a 30km/h speed limit under the framework of the theory of planned behavior, Transp. Policy 29 (2013) 199–208, https://doi.org/10.1016/j.tranpol.2013.06.003.
[30] A.A. Etika, N. Merat, O. Carsten, Do drivers differ in their attitudes on speed limit compliance between work and private settings? Results from a group of Nigerian drivers, Transp. Res. Part F Psychol. Behav. 73 (2020) 281–291, https://doi.org/10.1016/j.trf.2020.06.024.
[31] M.A. Javid, A.R. Al-Hashimi, Significance of attitudes, passion and cultural factors in driver's speeding behavior in Oman: application of theory of planned behavior, Int. J. Inj. Control Saf. Promot. 27 (2020) 172–180, https://doi.org/10.1080/17457300.2019.1695632.
[32] C. Atombo, C. Wu, H. Zhang, T.D. Wemegah, Perceived Enjoyment, Concentration, Intention and Speed Violation Behavior: Using Flow Theory and Theory of Planned Behavior 9588, 2017, https://doi.org/10.1080/15389588.2017.1307969.
[33] K.A. Bollen, R.A. Stine, Bootstrapping goodness-of-fit measures in structural equation models, Sociol. Methods Res. 21 (1992) 205–229, https://doi.org/10.1177/0049124192021002004.
[34] M.W. Browne, R. Cudeck, Alternative ways of assessing model fit, Sociol. Methods Res. 21 (1992) 230–258, https://doi.org/10.1177/0049124192021002005.
[35] L.T. Hu, B.P. M, Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives, Struct. Equ. Model. 6 (1999) 1–55.
[36] S.T.E.L. Hajjar, Statistical analysis: internal-consistency reliability and construct validity, Int. J. Quant. Qual. Res. Methods 6 (2018) 27–38. www.eajournals.org.
[37] W. Janssens, K. Wijnen, P. De Pelsmacker, P. Van Kenhove, Marketing Research with SPSS. http://www.lavoisier.fr/livre/notice.asp?ouvrage=1377458, 2008.
[38] R. Suhartini, L. Nurlaela Ekohariadi, U. Wahyuningsih, Y.I. Prihatina Yulistiana, Validity, reliability, intra-rater instrument parameter teaching factory and learning outcomes of industrial clothing, in: Proc. Int. Jt. Conf. Arts Humanit. 2021 (IJCAH 2021) 618, 2022, pp. 1230–1239, https://doi.org/10.2991/assehr.k.211223.214.
[39] J.C. Nunnally, I.H. Bernstein, Psychometric theory, Psychom. Theory. Third edit (1994) 1–736.
[40] D.S. Soper, A-priori Sample Size Calculator for Structural Equation Models [Software], Available From, https://www.danielsoper.com/statcalc, 2024.
[41] R. Weston, P.A. Gore, A brief guide to structural equation modeling, Couns. Psychol. 34 (2006) 719–751, https://doi.org/10.1177/0011000006286345.
[42] J.L. Arbuckle, IBM® SPSS® User's Guide Amos™ 24, IBM, Chicago, IL, 2016, pp. 1–720.
[43] M.A. Elliott, C.J. Armitage, C.J. Baughan, Using the theory of planned behaviour to predict observed driving behaviour, Br. J. Soc. Psychol. 46 (2007) 69–90, https://doi.org/10.1348/014466605X90801.
[44] J. Bordarie, Predicting intentions to comply with speed limits using a `decision tree' applied to an extended version of the theory of planned behaviour, Transp. Res. Part F Traffic Psychol. Behav. 63 (2019) 174–185, https://doi.org/10.1016/j.trf.2019.04.005.
[45] M. Nazri, A. Nazrul, H. Ibrahim, M.A. Abdulasalm, Extending the theory of planned behaviour to predict the intention to take the new high-speed rail for intercity travel in Libya: assessment of the in fl uence of novelty seeking, trust and external influence, Transp. Res. Part A 130 (2019) 373–384, https://doi.org/10.1016/j.tra.2019.09.058.
[46] M. Conner, R. Lawton, D. Parker, K. Chorlton, A.S.R. Manstead, S. Stradling, Application of the Theory of Planned Behaviour to the Prediction of Objectively Assessed Breaking of Posted Speed Limits, 2007, pp. 429–453, https://doi.org/10.1348/000712606X133597.
[47] C.J. Armitage, M. Conner, Efficacy of the theory of planned behaviour: a meta-analytic review, Br. J. Soc. Psychol. 40 (2001) 471–499, https://doi.org/10.1348/014466601164939.
[48] R. Rowe, E. Andrews, P.R. Harris, C.J. Armitage, F.P. McKenna, P. Norman, Identifying beliefs underlying pre-drivers' intentions to take risks: an application of the theory of planned behaviour, Accid. Anal. Prev. 89 (2016) 49–56, https://doi.org/10.1016/j.aap.2015.12.024.
[49] S. Michie, M. Richardson, M. Johnston, C. Abraham, J. Francis, W. Hardeman, M. P. Eccles, J. Cane, C.E. Wood, The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions, Ann. Behav. Med. 46 (2013) 81–95, https://doi.org/10.1007/s12160-013-9486-6.
[50] S. Michie, R.N. Carey, M. Johnston, A.J. Rothman, M. De Bruin, M.P. Kelly, L. E. Connell, From theory-inspired to theory-based interventions: a protocol for developing and testing a methodology for linking behaviour change techniques to theoretical mechanisms of action, Ann. Behav. Med. 52 (2018) 501–512, https://doi.org/10.1007/s12160-016-9816-6.
[51] L. Kay Bartholomew, Guy S. Parcel, Gerjo Kok, Nell H. Gottlieb, Planning Health Promotion Programs, 2018, https://doi.org/10.7748/en.25.10.15.s15.
[52] S. Michie, L. Atkins, R. West, The Behaviour Change Wheel: A Guide to Designing Interventions, 2014.
[53] L. van der Woning, Behavioral Change Interventions in the Military: The Academic Background, the Cultural Matches, and the Bottlenecks with the Integration, 2021.
[54] O. Service, M. Hallsworth, D. Halpern, F. Algate, R. Gallagher, S. Nguyen, S. Ruda, M. Sanders, M. Pelenur, A. Gyani, H. Harper, J. Reinhard, E. Kirkman, EAST Four Simple Ways to Apply Behavioural Insights, Nesta, 2014, p. 53. http://www.behaviouralinsights.co.uk/wp-content/uploads/2015/07/BIT-Publication-EAST_FA_WEB.pdf.