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Confirmatory Factor Analysis of Safe Driving Self-Efficacy among Tabriz Citizens

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ABSTRACT

Background: The advent of industrialization and the invention of the automobile have increased traffic accidents, impacting the quality of life. The purpose of this study is to evaluate the validity of the safe driving self-efficacy tool using confirmatory factor analysis (CFA) to confirm the factors extracted from the exploratory factor analysis stage and also to evaluate the reliability of this tool.
Methods: This study involved 600 individuals residing in Tabriz, aged 20-50 years. The questionnaire utilized in this study was a researcher-made tool and evaluated for structural validity, goodness-of-fit, and internal consistency. Construct validity was tested using the first and second-order CFA using AMOS23 software. The internal reliability of the questionnaire was determined based on Cronbach′s alpha coefficient ($\alpha > 0.7$).
Results: The study analyzed 589 questionnaires from 600 participants, with a mean age of 35.04 years (SD = 8.367). The majority of respondents had a driving experience and a history of traffic accidents, primarily within urban areas. The CFA also confirmed five factors with 42 questions, which showed positive results. The value of Cronbach′s alpha coefficient for all factors was more than 0.7.
Conclusion: Out of the 60 items in the questionnaire, 42 items were confirmed with appropriate goodness-of-fit indicators. The amalgamation of these constructs within the model effectively measures the concept of safe driving self-efficacy, thereby establishing the tool's reliability. As a result, this survey can serve as a valuable benchmark for evaluating individuals' self-efficacy concerning safe driving practices.

1. Introduction

Driving behavior has experienced a significant expansion of aggressive driving, resulting in damage and harm, making it a prominent social issue in the country. Iran is in a critical situation in terms of accidents. Traffic accidents are one of the most important health challenges in developing and developing countries (Moafian et al., 2013; Morgado et al., 2017). These accidents have severe physical, financial, social, cultural, and economic effects that pose a threat to human societies (WHO, 2015). Traffic accidents result in life loss, disability, and injury, affecting not only the individuals involved but also their families, particularly in developing countries where victims often face hidden costs (Rajasekaran, 2020). In recent years, the increased use of motor vehicles has led to an increase in transportation-related injuries, including trauma, in most parts of the world (Leproust et al., 2008). Currently, traffic accidents are the eighth leading cause of death in the world, and without appropriate intervention, they are projected to become the seventh leading cause of death by 2030 (WHO, 2015). It is worth noting that over 90% of deaths occur in countries with average incomes (Hyder, 2013). The Eastern Mediterranean countries, with 4.7% of the world's population and 6.5% of the world's vehicles, account for 9.69% of global traffic accidents (Soori & Khorasani-Zavareh, 2015). The burden of traffic

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accident injuries in Iranian society is very high (Bhalla et al., 2009) and has the highest rate of mortality due to driving accidents among countries with average incomes (Khorasani-Zavareh et al., 2009; Roshanfekr, 2019). A review of legal medical files in 2017 showed that 22,000 people die each year due to traffic accidents in Iran (Mohammadi et al., 2017), and the annual cost of these accidents exceeds four times the global standard ($ 6 billion) (Ainy et al., 2015). This is because the number of years of life lost due to road accident injuries is higher than other causes of death (Neghab et al., 2008; Peden et al., 2002). In Iran, traffic accidents are the most common cause of injury and rank second in terms of premature deaths, following cardiovascular and cerebrovascular diseases surpassing disabilities. According to the president of Tabriz University of Medical Sciences, driving accidents are the third leading cause of death in East Azerbaijan province (ISNA, 1393). Traffic accidents are linked to the inappropriate performance of safety systems, vehicle factors, road infrastructure, and user behavior. (Borsos et al., 2015; Evans, 1996; Saeini, 2016). Moreover, according to most studies, the determining factor in 90-95 % of all traffic accidents is human error (Karacasu & Er, 2011; Vlkovský et al., 2017). One of the main factors leading to driving accidents is risky driving behavior among young and inexperienced drivers (Shappell & Wiegmann, 2013). It is estimated that one out of every three traffic accidents is caused by driver behavior, which accounts for 95 % of accidents (Yang et al., 2019). Human factors include driving skills and driving style, with risky driving being a dangerous and legal violation-related type of driving (Petridou & Moustaki, 2000). These risky driving behaviors are mainly influenced by age, emotional state while driving, driving experience, and inappropriate driving behaviors such as eating and drinking, alcohol consumption, and talking on the phone) (Saadati, 2020). Human factors contributing to driving accidents include long-term factors like inexperience, illness, and aging, as well as short-term factors like sleepiness, fatigue, and drug effects (Mostafavi et al., 2021; Petridou & Moustaki, 2000; Saadati, 2020). Driving styles can be categorized into three types: defensive (respecting traffic laws), risky (overestimating skills and disregarding others), and neutral (bordering between defensive and risky driving) (Bucsuházy et al., 2020). Major causes of traffic accidents in Iran include lack of road awareness, exceeding safe speed limits, and left-handed overtaking (Bai N, 2016). Consequently, understanding and examining safe and confident driving behavior is essential as a main strategy for reducing driving injuries (Razmara et al., 2018). Studying risky driving behavior and its influencing factors in a particular culture can contribute to accident reduction by addressing societal values, habits, and attitudes (Dadipoor et al., 2020). Health education and promotion specialists are responsible for creating tools to measure and evaluate the psychological characteristics of study participants (Barry et al., 2014). Research results should be reliable and assessable, with validity and reliability being crucial components of any measurement tool (Oreyzi & Haghayegh, 2010). This tool was designed by Jalalian in 2020 (Jalalian et al., 2021) and the purpose of this study is to evaluate the validity of the safe driving self-efficacy tool using confirmatory factor analysis (CFA) to confirm the factors extracted from the exploratory factor analysis stage and also to evaluate the reliability of this tool.

2. Materials and Methods

This study employed a cross-sectional design and was conducted over six months from December 4, 2021, to May 24, 2022. A total of 600 citizens aged 20 to 50 who drove their vehicles were selected using a convenience sampling method from the city of Tabriz. In this research, the questionnaire developed by Jalalian (Jalalian et al., 2021) was used as a measurement tool. This questionnaire consisted of three sections. The first section included six questions that measured participants' demographic information, including age, gender, education level, marital status, and occupation. The second section comprised nine questions that evaluated participants' driving history and accidents. The third section was related to a self-efficacy questionnaire for safe driving, which included 60 questions with a 5-point Likert scale ranging from "completely agree" to "completely disagree". This section aimed to measure participants' self-efficacy for safe driving behavior in five dimensions, including attention to driving regulations (16 items), attention to safety issues in driving (9 items), prohibitions, signs, and warnings (18 items), attention to technical aspects of driving (8 items), and attention to driving culture (9items). The score range for the self-efficacy questionnaire was between 60 and 300, with higher scores indicating higher levels of self-efficacy for safe driving. In this study, the factors of the questionnaire were evaluated using first and second-order factor analyses, employing the most common goodness-of-fit indices based on the acceptance threshold. There is no golden rule for evaluating the suitability of a model. However, reporting various indices is essential as they often capture different aspects of the model (Hooper et al., 2008). Therefore, in this study, the goodness-of-fit of the model with the data was evaluated using chi-square distribution (2), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Incremental Fit Index (IFI), Tuker – Lewis index (TLI), Parsimonious comparative fit index (PCFI), and Parsimonious normed fit index (PNFI). It should be noted that these indices alone do not indicate goodness-of-fit but should be interpreted in conjunction with each other (Ebadi et al., 2017). The convergent and discriminant validity of self-efficacy for safe driving was evaluated using the extracted average variance (AVE) and maximum shared squared variance (MSV). Convergent validity is established when AVE > 0.5, while discriminant validity is established when MSV < AVE (Hair et al., 2006). To evaluate the internal consistency of the tool, Cronbach's alpha coefficient and composite reliability (CR) were estimated, and values higher than 0.7 were considered acceptable for Cronbach's alpha coefficient (Javali et al., 2011) and construct reliability (Schreiber et al., 2006). The normal distribution of the data, outliers, and missing data were evaluated separately. The presence of multivariate outliers was evaluated using the Mahala Nobis method ($p < 0.001$), and the violation of multivariate normality was evaluated using the Mardia coefficient (8 >). Missing data were replaced using the nearest median imputation method. Participants whose response deviation was less than 0.3 were identified and removed as indifferent cases, indicating a lack of concentration or careful reading of the questionnaire (Pahlevan Sharif, 2020). Data analysis was done using SPSS version 23 and AMOS version 23 statistical software. Confirmatory factor analysis was performed, using the maximum likelihood method to estimate the model parameters.

3. Results and Discussion

Out of a total of 600 questionnaires collected, 589 questionnaires were analyzed. The mean age of the participants in this study was 35.04 ± 4.35 years, with an age range of 20 to 50 years. The demographic characteristics of the participants are shown in Table 1. Information on participants' driving history, accidents, location of accidents, and insurance is provided in Table 2, offering insights into their driving experiences and safety practices. Based on the result, the majority of participants (42.4%) had 1 to 9 years of driving experience, and 66.7% of the participants had a history of accidents, while the remaining 33.3% reported no accidents. The urban areas were the most common locations for accidents (44%), and approximately 50% of accidents involved collisions with other vehicles. Furthermore, 51.6% of drivers did not have car insurance.

Table 1. The demographic characteristics of the participants

Variable	Grouping	Number	Percentage
Gender	Male	331	56.2
	Female	258	43.8
Age	19-25	121	20.5
	26-35	209	35.5
	36-45	178	30.2
	46-55	81	13.8
Marital status	Single	270	45.8
	Married	277	47.0
	Divorced	32	5.4
	Other	10	1.7
Level of Education	High school	50	8.5
	Diploma	154	26.1
	Associate Degree	63	10.7
	Bachelor's degree and higher	322	54.7
Job	Housekeeper	84	14.3
	Employed in the public and private sector	160	27.2
	Frelance job	212	36.1
	Student	97	16.5
	Unemployed	35	5.9
	Total	589	100.0

In the CFA, the results showed that the initial model with 60 questions did not match the data, and some questions had a factor loading below 0.5. Therefore, in the first step, questions with a factor loading less than 0.5 were removed, and then the model was re-evaluated (Figure 1). As shown in Figure 2, to improve the model, 14 pairs of measurement errors were established. After examining the modification indices, the final six-factor model fits the data well. The factor loadings for all items ranged from 0.58 to 0.94 and were significant ($p < 0.001$). The goodness of fit indices is shown in Table 3. Given the high covariance and correlation between the constructs of the safe driving self-efficacy questionnaire, a second-order CFA was deemed appropriate. Then, following the first-order factor analysis, a second-order factor analysis was conducted to assess the compatibility of all factors with the general concept of self-efficacy for safe driving. Figure 3 provides a schematic view of the evaluation of the overall fit of the second-order measurement model, further illustrating the effectiveness of the model. The goodness of fit indices for the second-order factor analysis are displayed in Table 3. The convergent and discriminant validity of self-efficacy for safe driving was evaluated using the AVE and MSV. As Table 4 shows, all five factors have an acceptable temporal consistency (0.7), and the evaluation of convergent and divergent validity shows that the AVE and MSV criteria indicate good convergent validity but not good divergent validity.

Table 2. Summary of participants' driving history, accidents, and insurance information

Variable	Grouping	Number	Percentage
Driving experience (years)	1-9	250	42.4
	10-19	206	35.0
	20-42	133	22.6
Accident history	Yes	393	66.7
	No	195	33.1
	No response	1	0.2
Number of accidents	0	195	33.1
	1	151	25.6
	2	61	10.4
	3	51	8.7
	4	16	2.7
	5	29	4.9
	6 and more	86	14.6
Location of accidents	Inside the city limits	259	44.0
	Outside the city limits	56	9.5
	Inside the urban area and outside the urban area	77	13.1
	No accident	195	33.1
	No response	1	0.03
The obstacle that caused the accident	Another car	298	50.6
	Pedestrian	12	2.0
	Objects	39	6.6
	Animals	22	3.7
	Other	22	3.7
	No response	1	0.2
Number of times using car insurance	0	304	51.6
	1	161	27.3
	3	45	7.6
	3 and more	77	13.11
	No response	2	0.3
	Total	589	100.0

Table 3. Goodness-of-fit indices for the first and second-order factor analysis of the self-efficacy for safe driving tool

Confirmatory factor analysis	X2	df	*p*-value	CMIN/DF	RMSEA	CFI	IFI	TLI	PNFI	PCFI
First order CFA	1697.290	795	0.000	2.127	.067	.908	0.909	.901	.776	.839
Second order CFA	1702.599	802	0.000	2.213	.067	.908	.908	.901	.782	.846

* CMIN/DF: Chi-square/degree-of-freedom ratio; RMSEA: Root Mean Square Error of Approximation; PCFI: Parsimonious Comparative Fit Index; PNFI: Parsimonious Normed Fit Index; IFI: Incremental Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index. Fit indices: PNFI, PCFI (> 0.5), CFI, IFI (> 0.9), RMSEA (> 0.08), CMIN/DF (> 3 good, > 5 acceptable).

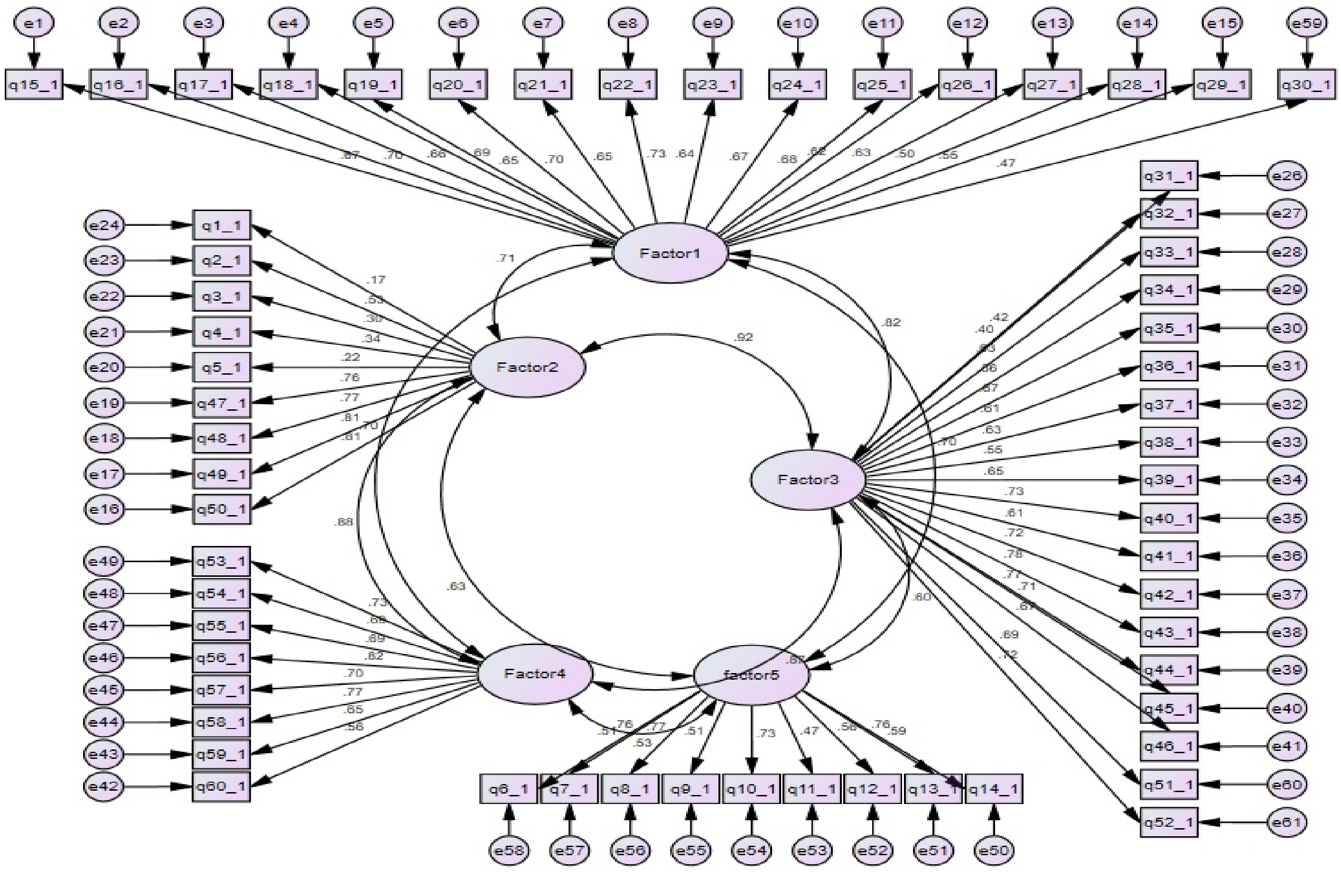

Figure 1. First order Confirmatory factor analysis (CFA)

Table 4. Reliability of different constructs of the safe driving self-efficacy questionnaire

Factor	Number of items	α	CR	AVE	MSV
Factor 1 (Paying attention to driving regulations)	13 items: 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27	0.933	0.933	0.521	0.64
Factor 2 (Observing safety issues while driving)	4 items: 47,48,49,50	0.950	0.949	0.824	0.864
Factor 3 (Prohibitions, signs and warnings)	13 items: 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46	0.955	0.956	0.634	0.792
Factor 4 (Observe technical points while driving)	8 items: 53, 54, 55, 56, 57, 58, 59, 60	0.919	0.924	0.610	0.792
Factor 5 (Attention to driving culture)	4 items: 7, 8, 10, 13	0.895	0.884	0.658	0.435

* α: Cronbach′s alpha coefficients; CR: construct reliability; AVE: average variance extracted; MSV: maximum shared squared variance

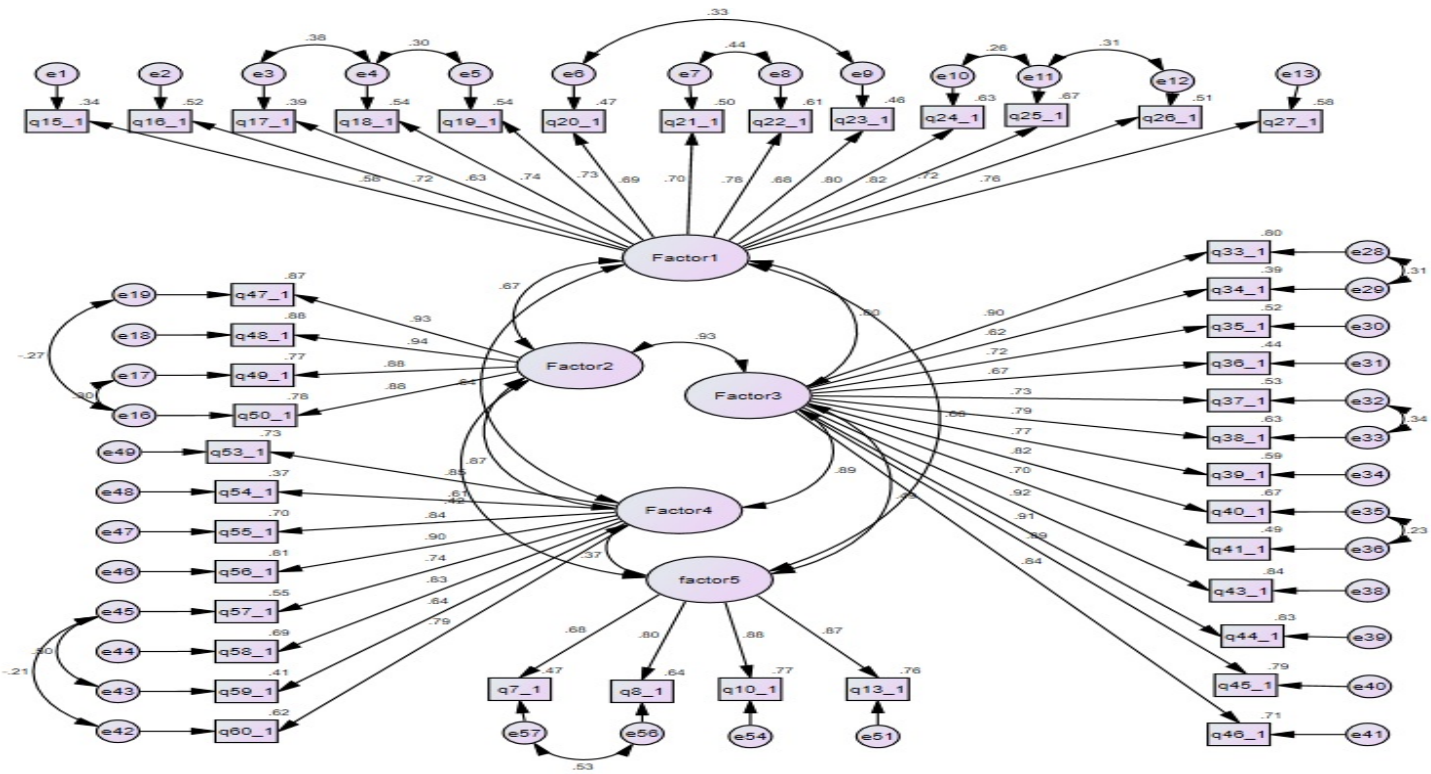

Figure 2. Revised First Order Confirmatory factor analysis (CFA)

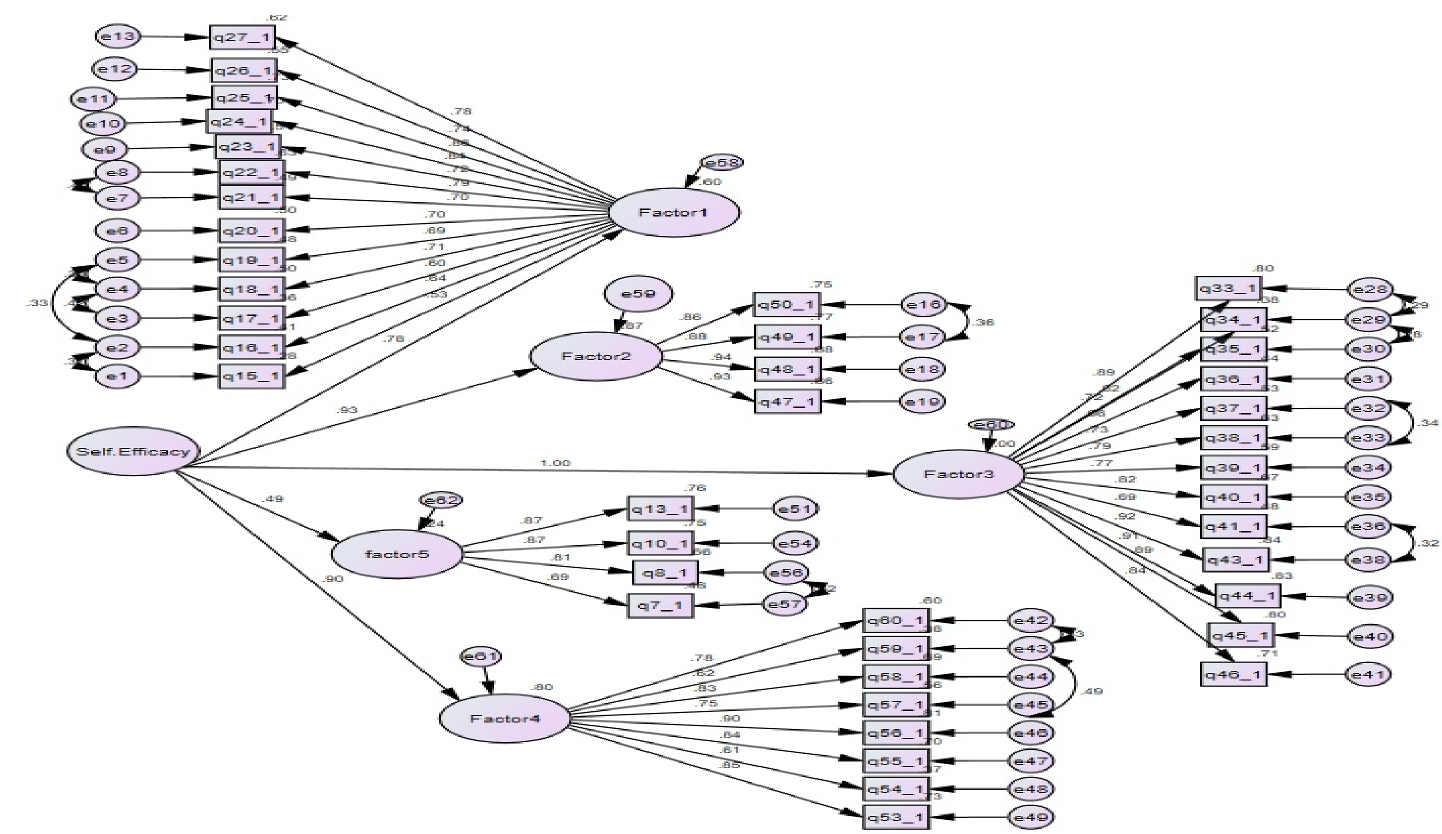

Figure 3. Second-order Order Confirmatory factor analysis (CFA)

4. Conclusion

The self-efficacy for safe driving tool, derived from the questionnaire developed by Jalalian, *et al.* (Jalalian, 2021) emerged as a robust instrument for evaluating individuals' self-efficacy related to safe driving behavior. The questionnaire exhibited structural validity, confirmed by exploratory factor analysis, and displayed high internal consistency, with a Cronbach's alpha coefficient of α= 0.972. In our study, confirmatory factor analysis further strengthened the reliability of the tool, as it demonstrated a good fit between the proposed model and the collected data. We even conducted a second-order factor analysis to account for latent factors. The multidimensional nature of this questionnaire, with its confirmed first and second-order factor structures, substantiates its viability as a standard assessment tool tailored to evaluate self-efficacy for safe driving behavior in the specific cultural context of Iran.

Authors' Contributions

Arezou Aghapour: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Visualization; Writing–original draft; Writing-review & editing. Mohammad Masoud Vakili: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing-review & editing. Khadijeh Hajimiri: Formal analysis; Methodology; Software; Validation; Visualization.

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Conflicts of Interest

There was no conflict of interest in this study.

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Ethical considerations

Obtaining permission from the ethics committee of the university. Obtaining the company's informed and voluntary consent from the samples. Confidentiality of data and anonymity of responses. Presentation of the results in the form of tables and as a percentage. (Project Code: IR.ZUMS.REC.1400.141).

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