

Article

Exploring the Factors Influencing the Safety of Young Novice Drivers: A Qualitative Approach Based on Grounded Theory

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Abstract: Risky driving behaviors of young novice drivers and related crashes pose not only a threat to road safety but also a significant challenge to sustainable development. The high rate of traffic crashes involving young drivers leads to substantial losses in human capital, productivity, and labor, which are irreparable and place a strain on societal resources. Addressing the safety issues of this vital group in society is crucial for promoting the long-term social and economic sustainability of communities. Despite this, studies have lacked a comprehensive explanation of the safety issues surrounding young novice drivers. Therefore, the aim of this study is to identify factors affecting the safety of young novice drivers in Iran, a developing country with a significant young population. The study uses a qualitative approach that is built on grounded theory to reveal the model. The statistical population of the study is specialists, experts, and researchers in the field of road safety who are spread across Iran. The data collection phase was realized through the conduction of semi-structured interviews with 36 of them, and the analysis process was continued until complete theoretical saturation was achieved. The research data were then analyzed using the coding method based on the systematic design of Strauss and Corbin's grounded theory. Finally, the categories were organized into seventeen subcategories within the six dimensions of the paradigm model: main category (three subcategories), causal factors (three subcategories), contextual factors (three subcategories), strategies (two subcategories), environmental conditions (three subcategories), and consequences (three subcategories). These findings not only provide a deep understanding of the safety issues faced by young novice drivers but also offer strategies that can contribute to improving road safety, thereby fostering social sustainability. Enhancing driver safety is crucial for reducing the economic and social costs of road crashes, which aligns with the broader goals of sustainable development by preserving human capital and societal well-being.

Keywords: young novice drivers; road safety; grounded theory; semi-structured interview; sustainable development



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1. Introduction

The World Health Organization (WHO) report shows that, between 2000 and 2016, the number of deaths caused by road crashes increased from approximately 1.15 million to 1.35 million worldwide [1]. Every year, approximately 1.3 million people are killed in road crashes, and between 20 and 50 million suffer severe injuries, with many of them considered disabled [2]. Road crashes are regarded as a leading cause of death, which is why governments are making significant efforts to prevent them [3]. In the meantime, Young novice drivers between the ages of 18 and 24 experience elevated rates of traffic and road fatalities across high-income, middle-income, and low-income countries [1], and their crashes have caused many concerns [4]. Extensive research in traffic safety provides increasing evidence that risky driving behaviors, especially among young and

inexperienced drivers, significantly contribute to traffic crashes and pose a serious threat to public safety [5–7]. According to [8], human-related, infrastructure-related, and vehicle-related factors and inadequate law enforcement are identified as risk factors in traffic crashes. Human factors have been consistently identified as the main and important cause of crashes, and road crashes have been strongly related to driver behavior [9]. Road users between the ages of 18 and 24 are more likely to be killed in traffic crashes than any other age group globally [10]. In the European Union, young road users accounted for 12% of fatalities in 2019 despite comprising only 8% of the population [11]. In 2015, drivers with fewer than three years of driving experience contributed to 28.7% of traffic accidents and 25.63% of traffic fatalities in China [12]. In 2016, Australian drivers aged 17–25 comprised just 15% of licensed drivers, yet they represented 22% of traffic accident fatalities [13]. In Germany, nearly 66,000 road traffic accidents involving young drivers resulted in deaths or injuries in 2017. This means that novice German drivers are twice as likely to be involved in a vehicle crash compared to their older and more experienced counterparts [14].

The overrepresentation of young, predominantly male drivers appears to be consistent across countries regardless of their overall level of traffic safety. For instance, European countries such as Sweden (16.3%), the United Kingdom (15.0%), and Finland (16.0%) exhibit even higher proportions of young drivers despite being among the safest countries globally in terms of traffic safety [10]. In Finland, the road fatality rate per 100,000 vehicles in 2016 stood at 4.7 fatalities. Among 18–20-year-olds, this figure was 11.1, while for 21–24-year-olds, it was 7.3 [15]. In that same year, out of the 5,911 individuals injured in traffic crashes in Finland, 584 were aged 18–20, and 481 were aged 21–24 [15]. These statistics reflect the fact that injuries and fatalities among young road users remain an ongoing challenge, even in the safest countries, despite improvements in overall road safety [16]. Addressing the safety of young novice drivers is vital not only for improving traffic safety but also for achieving sustainable development goals.

Reducing traffic fatalities among young novice drivers can significantly decrease the economic and social burden on societies, contributing to the sustainability of human capital and promoting safer, more resilient communities.

Several factors influence the safety of young novice drivers, including individual characteristics, contextual factors, and external influences. Individual characteristics encompass aspects such as risk perception, driving style, risky decision-making, and alcohol or drug use [17–19]. Contextual factors, including the driving environment, weather conditions, and road infrastructure, can also affect safety. For example, poor roads or adverse weather conditions can increase the likelihood of crashes. Young novice drivers tend to exhibit unusual behaviors compared to other drivers, and they often do not adjust their risky behavior even in adverse environmental conditions [20,21]. In addition, social influences twanging on youngsters' driving behavior, such as peer pressure and the responses of family members towards driving, are also determinants of the attitude and activity of fresh drivers [22–24]. Moreover, the availability of courses that prepare new drivers and educate them on driving rules, hazard perception, and traffic safety contributes to their overall safety, as comprehensive courses can enhance their skills and promote safe driving behavior [25–27]. It follows all of these acts as an integrative medley of the individual, contextual, and societal components that need to be mended in the case of augmenting the safety of young novice drivers.

Among the risky driving behaviors that are often observed among young novice drivers are speeding violations [28,29]. In the same direction, an analysis of crash causes in Europe also reveals that young drivers tend to drive at higher speeds compared to older drivers (those aged over 24 years) [30]. An analysis of crashes involving young drivers in Finland has also shown that it is common for these drivers to exceed the speed limit by more than 10 km per hour [16]. Some other risky driving behaviors of young novice drivers include hazardous overtaking maneuvers [31] and tailgating [32]. Additionally, distraction while driving has been identified as one of the causes of crashes among young drivers [33]. Researchers have discovered that young drivers who encounter distractions

while driving are less attentive to potentially hazardous situations [34]. It is important to note that distraction has become a major global health concern [35,36]. It has been specifically demonstrated that visual distraction increases the likelihood of involvement in crashes [37]. Among these distractions, the use of mobile phones is one of the most common, particularly for young novice drivers [38,39]. In this regard, one of the most important and growing areas of road safety research is related to the use of smartphones while driving [1]. In the meantime, studies show that reckless driving among young people, especially young men, is a global problem and one of the main causes of injuries and fatalities worldwide [40]. Studies suggest that the tendency to take risks while driving fulfills functions such as enhancing feelings of power, boosting self-esteem, and gaining social recognition [41]. Additionally, studies show that when perceived social norms encourage risk-taking while driving (e.g., viewing risky driving as acceptable or receiving positive feedback for such behavior), drivers are more likely to engage in behaviors like speeding and driving under the influence of alcohol [42–49].

Young novice drivers are a major factor in the increase in road crashes [50]. Individuals in these groups have widely been reported to be a high-risk group, engaging in risky driving behaviors that lead to road crashes [46,51]. Despite the UN General Assembly declaring 2011–2020 as the Global Road Safety Decade in 2010, there has been insufficient global effort to stop road crashes. Additionally, road crashes are addressed in the UN Sustainable Development Goals (SDG) under targets 3.6 and 11.2 [52]. This has prompted heightened global efforts to collaboratively reduce road crashes, including the implementation of programs like the UN Decade of Action plan.

In the meantime, previous investigations have mostly focused on the burden, trends, and causes of road crashes, while a clear gap remains in exploring the safety issues of young novice drivers, especially in developing countries like Iran. While much of the existing literature focuses on traffic management or the behavior of experienced drivers, the specific risks and hazard factors faced by young novices have not been extensively discussed. In light of changes in road infrastructure and youth behavior, it has become increasingly important to identify effective measures for improving road safety for this group. This research aims to fill that gap. By examining the safety phenomenon of young novice drivers through a qualitative grounded theory approach, the study will develop strategies for preventing road accidents and enhancing road safety.

A qualitative approach based on grounded theory is a systematic methodology used to investigate and understand complex social phenomena. This method allows researchers to gather detailed, in-depth insights from participants, such as through semi-structured interviews, enabling a deeper exploration of the experiences and perceptions of subject matter experts in the field of road safety. The data obtained by this method are directly extracted from participants in the real world, and as first-hand data, they more accurately represent the real-world situation. By generating new theories derived from empirical data rather than relying solely on existing ones, grounded theory is particularly useful for studying areas that have not been extensively researched, such as the safety of young novice drivers.

A thorough investigation of these issues is essential for advising individuals, companies, and authorities in designing or implementing interventions that respect environmental, social, and economic sustainability. By identifying the causal relationships between risk factors and targeted solutions, this research seeks to address the gaps in existing frameworks and provide practical solutions to the safety challenges faced by young novice drivers.

2. Methodology

In terms of purpose, the current research is a qualitative study. Qualitative research is a type of study in which the researcher collects and interprets data, making them as much a part of the research process as the participants and the data itself. Qualitative research uses an open and flexible research design, which contrasts with the concept of adhering to strict predetermined guidelines, a key aspect of quantitative research [53]. After

conducting the initial investigations, it was decided that the grounded theory method be used to present a theory at an intermediate level. Participants in the qualitative research were selected to obtain the most information about the phenomenon under investigation, and a semi-structured interview was conducted with them. The interview period was from mid-December 2022 to late April 2023. The ethics approval for this study was obtained from the College of Engineering, University of Tehran (82-C-484).

2.1. The Theoretical Foundation of Grounded Theory

Grounded theory is a form of qualitative research introduced by [54], which was developed with the aim of creating an emergent theory from within the data. Although this methodology was designed by two sociologists, its use is not limited to the social sciences. This methodology has various applications across many scientific fields. This methodology provides the possibility of identifying and determining general concepts, offering theoretical explanations beyond existing knowledge. This, in turn, provides new insights into a range of experiences and phenomena.

According to the research literature on the safety of young novice drivers, a precise definition and differentiation of the variables are not provided. In the existing literature, this phenomenon is relatively vague and poorly understood, and its important variables should be identified. It is also necessary to provide questions for further research. Therefore, according to the primary goal of this research, which is to design a safety pattern related to young novice drivers, it has been decided, after conducting preliminary investigations, that the grounded theory method is used to present an intermediate-level theory. It is recommended that this method is used in situations where there is little understanding of a phenomenon or where existing theories lack a complete explanation of the phenomenon in question. A researcher who intends to examine people's experiences in order to create a theory can benefit from using the grounded theory method [55].

2.2. Semi-Structured Interview

The information-gathering tool in this study is the semi-structured interview. Semi-structured interviews provide opportunities to maintain coherence while covering the concepts raised during an interview. In a semi-structured interview, some topics are selected based on practice and the literature review before starting the research. However, the timing and manner of presenting these topics are not structured. Many researchers feel comfortable having a list of topics to refer to in advance, especially if the participants are not very talkative. In semi-structured interviews, similar topics are covered in each interview. After asking the questions on the list, participants are free to raise any points they think are related to the topic. Researchers can also ask additional questions to clarify certain points or to further investigate a topic [53].

In this study, the statistical population was defined based on the strategy selected for conducting research using a qualitative approach grounded in grounded theory. In line with the steps of the research strategy, the researcher consulted subject matter experts to gather firsthand data. Therefore, the samples for this research consisted of specialists and experts in the field of road safety, including university professors, senior managers, and researchers across Iran who possessed sufficient knowledge about the subject. In the present study, efforts were made to interview all knowledgeable and opinionated groups on the issue of young novice driver safety. A preliminary list of about 46 qualified individuals was selected for interviews and contacted via email. Out of those, 28 responded positively and were subsequently interviewed. At the end of each interview, the interviewees were asked to provide suggestions and to introduce other qualified individuals. The interviews continued until it was felt that the responses were becoming repetitive and no longer added new information, indicating that the findings had reached saturation. In this study, 36 interviews were conducted. During the information-gathering process, concepts and propositions gradually accumulated. By the 16th interview, the summary and review of propositions led us to the main category of designing a safety pattern for young novice

drivers. Subsequently, efforts were made to organize and focus the next questions around this category. By the 24th interview, theoretical saturation of the data was largely achieved. However, to ensure completeness and fill any conceptual gaps in the model, the interviews continued until the final interview.

2.3. Participants

The study involved 36 interviewees. In this case, the sample size is the one that is the number of people who have participated in the study and whose responses have been processed. The data offered are about the diversity in gender and educational background. Out of 36 participants, 28 were men, and 8 were women. This infers that the approximately 78% of the participant population is male, and the 22% is female.

The educational qualifications of the interviewees are broken down into four categories, showing a spread across different academic levels: 12 individuals had a doctorate degree, which suggests they are highly specialized in their fields, likely providing in-depth insights from a well-informed standpoint; 8 were doctoral students, indicating they are in the process of obtaining a doctorate and may contribute fresh perspectives from the academic front; 10 had a master's degree, implying advanced, though not doctoral, expertise in their field; and 6 had a bachelor's degree, representing participants with foundational knowledge in their areas of study or work. This breakdown indicates that the majority of interviewees had advanced degrees, with around one-third holding doctorates, another third at the master's level, and the remaining participants split between doctoral students and those with bachelor's degrees. This level of educational diversity can provide a variety of perspectives, with more highly educated participants potentially offering specialized knowledge, while those with bachelor's degrees might offer more practical or applied viewpoints. Analyzing interviews with this demographic spread allows researchers to observe possible differences in perspectives influenced by gender and educational background, leading to richer, more nuanced findings.

2.4. Coding Process

The qualitative data for this study were analyzed using a systematic coding process grounded in the design proposed by Strauss and Corbin (1998) [56]. The analysis process followed three key stages: open coding, axial coding, and selective coding.

2.4.1. Open Coding

To begin with, the transcripts of the interviews were decomposed into smaller units, e.g., lines or paragraphs, that conveyed discrete messages. Early on in the process, open codes (ideas) were drawn out from the fragments. This step was to make sure that any ideas stuck in the memory of the individual were not missed in the data. Initially, the concepts that were identified were put into broader categories, which was a means of getting to the patterns that were the reflections of the data. The continual process of uncovering nodes from the initial codes and grouping them into the broader category was iterative.

2.4.2. Axial Coding

In the second stage, the focus shifted to establishing relationships among the categories identified during open coding. This stage began with identifying a main category that served as the core phenomenon in the study. The remaining categories were then organized around this core, forming five major clusters: (1) causal factors, (2) strategies, (3) contextual factors, (4) environmental conditions, and (5) consequences. Axial coding helped structure the categories into a coherent framework, linking causes, actions, and outcomes based on participants' experiences.

2.4.3. Selective Coding

Finally, when selective coding is completed, the relationships between the data's key categories are combined to synthesize a theory. This model is the perspective of the

identified factors and serves as a link between the main problem and its related causes, contexts, strategies, and consequences. The final part, which was selective coding, redefined the theory when all the categories came together to form a coherent framework, which was parallel to that of the paradigm model of grounded theory.

The coding process was ongoing, whereby large numbers of open codes were perceived at the beginning. Nonetheless, in the course of multiple iterations of rating and categorization, the duplicate and overlapping concepts were aggregated, leading to a clearer and more meaningful set of categories.

2.4.4. Validity and Reliability Measures

To verify that the data are accurate and trustworthy, various approaches have been used to increase validity and reliability:

- **Member Checking:** A subgroup of subjects questioned the analysis and specifically organized data in the last report. Simultaneously, the information they gave us was very precise and corresponded to their ideas and judgments, which was the most important thing, and their feedback played a vital role in verifying the accuracy of the analysis [57].
- **Peer Examination:** Three college teachers, two pros in the area of road safety, and two doctors from related fields conducted a review with the researchers. This was a study among others, being serious that the categories were well founded and that the procedure was followed properly.
- **Collaborative Analysis:** Throughout the analysis process, the participants were actively involved in the interpretation and analysis of the data. Their active participation levels ensured that the findings were contextually relevant and stemmed from the real-life experiences of the individuals.
- **Researcher Reflexivity:** In addition, the researcher initiated conscientiousness to nullify personal influences and adhere to objectives. Reflexive techniques were used to consistently scrutinize the researcher's perspectives and investigate how these biases can distort the coding and the interpretation of data [58].

This systematic approach, guided by grounded theory concepts, was the guarantee for a complete and strict analysis, which produced findings that were both real and valuable.

2.5. Qualitative Data Analysis

In qualitative data analysis, the primary function is to identify categories, concepts, and dimensions, as well as to reveal connections among these elements. The methodical research strategy of grounded theory advocates structured data analysis, which can be conducted in three coding steps: open coding, axial coding, and selective coding. The design of such a method is to give a descriptive quality and to visualize the theory. This phase of the research will make the qualitative data the subjects of the coding scheme, as articulated by Strauss and Corbin as the systematic design [56].

Performing these steps requires creating a figure called "coding figure", which illustrates the relationships between causal factors, strategies, environmental conditions, contextual factors, and consequences (Figure 1). In this figure, categories from open coding are shown on the right side, while axial coding categories are displayed on the left. Selective coding, by contrast, is the process of theory integration and refinement. During integration, categories are organized around a central explanatory concept, a process that begins early in the analysis and often continues until the final write-up [56].

In this research, the coding figure will serve as a tool for integration. Categories will be revised multiple times; some rare concepts may be removed, and the alignment between theory and data will be carefully examined. When viewing the coding pattern from right to left, we observe that causal factors influence the main category; the main category, contextual factors, and environmental conditions affect strategies, and these strategies, in turn, impact the consequences [59].

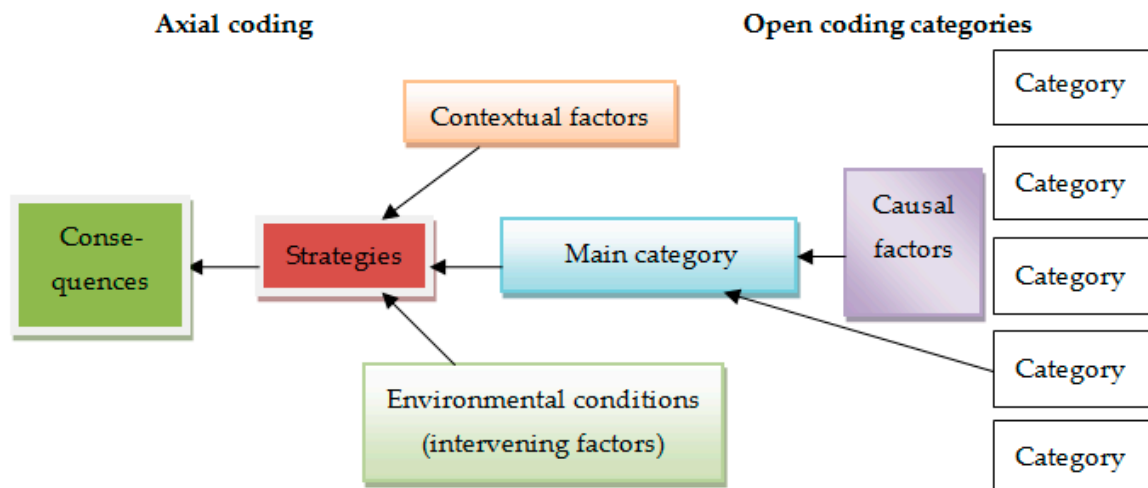


Figure 1. Demonstrating the coding process in qualitative data analysis.

3. Results

In the phase of extracting open codes, 258 open codes were obtained. However, after each stage of classification and data review, duplicate concepts were removed, and similar concepts were merged. This process resulted in 74 initial conceptual propositions in the selective coding stage, with 17 subcategories. It should also be noted that the data analysis was performed with accuracy more than ten times to achieve reasonable saturation for the main categories, subcategories, and their dimensions. The boundaries of each main category and subcategory were not definitively determined at the beginning of the analysis and were revised throughout the process. Open coding and axial coding were stopped when the following occurred:

- A meaningful classification was obtained after reviewing the transcripts of the interviews several times.
- Subcategories and features were repeatedly identified.
- Relevant and new information could not be found in the interview transcripts. Even if new information was found, it matched the existing classification.

The final classification is shown in Table 1 and Figure 2. This classification should not be considered the only possible one with absolute limits. However, it can be considered sufficient for the next stages of data analysis and questionnaire design in the future.

Table 1. Results of open coding and axial coding, along with the subcategories.

Axial Codes	Subcategories	Open Codes
Main category (the safety of young novice drivers)	Driver safety	Fasten seat belt while driving
		Observe the speed limit while driving
		Observing a safe distance while driving (longitudinal and transverse distance)
		Paying attention to the surroundings while driving
		Avoiding emotional behaviors
	Road safety	Compliance with road engineering and safety principles in road design (according to standards)
		Use of standard signs on roads
		Appropriate geometric design of the roads
	Car safety	Checking the car before driving (tire inflation, engine oil, etc.)
		Compliance with standards in car manufacturing
		Car safety in terms of pillar, roof, and brake safety
		Car safety from the point of view of mechanical engineering in car manufacturing companies

Table 1. Cont.

Axial Codes	Subcategories	Open Codes
Causal factors	Human factors	Use of safety equipment while driving
		Experience and skills of young novice drivers
		The skills of young novice drivers in momentary decisions
		No use of stimulants or distractions (such as mobile phones, eating and drinking, drugs, etc.)
		Having sufficient training and experience in driving on intercity roads
	Road characteristics	Compliance with the necessary standards in road construction
		No potholes on the road
		The right screws
		Good viewing angle for the driver
		Safe design of intersections and interchanges
	Car safety equipment	Appropriate design and compliance with standards in the car
		Observance of safety tips in car braking
		Having airbags and equipping the car with other safety equipment
Contextual factors	Executive agents and institutions involved in road traffic	Traffic engineering
		Road engineering
		Car production
	Cultural and social factors	Society and culture
		Family institution
		Social networks
		Communication networks such as radio and television
	Legal and executive factors	Providing the necessary training to young novice drivers by the traffic department
		Enhancement of roads by the Ministry of Roads and Urban Development
		The enactment of preventive laws and their proper implementation by the legislative, judicial, and executive powers.
Strategies	Strategies at the national level	Appropriate budget allocation for securing cars and roads
		Applying fines and addressing risky driving behaviors
		Use of incentives for safe driving
		Providing training and using educational communication tools
	Specialized strategies	Securing roads by installing appropriate traffic signs
		Improving driver safety by enhancing individual driving skills
		Extending the duration of driving training and utilizing up-to-date technologies in driver education
		Monitoring, controlling, and managing the false emotions of young novice drivers
		Encouraging compliance with traffic laws through relevant institutions
Environmental conditions (intervening factors)	Legal and official interveners	The executive branch
		The legislative branch
		The judicial branch
		The Ministry of Roads and Urban Development
		Traffic police
		Municipalities and social institutions

Table 1. Cont.

Axial Codes	Subcategories	Open Codes
Environmental conditions (intervening factors)	Unofficial interveners	Political and legal factors (non-implementation or incomplete implementation of traffic laws)
		Economic factors (lack of sufficient funds in the fields of road construction and traffic improvement and the production of low-quality cars)
		Cultural factors (having the wrong culture of driving and lack of proper training and culture)
		Social factors (lack of appropriate social media and communication and lack of social contexts necessary for safe driving)
	Internal environment (key actors)	Development of information and communication technology
		Knowledge of driving culture (becoming a scientist)
		Having strategic thinking about the effective factors in traffic safety
		Development of effective social networks
		Paying attention to the wishes and expectations of different people in the community
		Gradual increase in the number of actors and stakeholders in traffic safety
Consequences	Individual consequences	Reduce crashes
		Reducing youth mortality
		Creating mental peace in drivers
		Reduction of bereaved families
		Having a strong and safe generation in the field of safe transportation
	Social consequences	Preventing the wastage of the country's young talents
		Reducing the breakdown of families
		Having a dynamic and lively society and increasing life expectancy in the country
		Institutionalization of the culture of following traffic rules from the moment of obtaining a driver's license
	Economic consequences	Cost reduction for the individual and society
		Preventing the loss of human resources as the greatest capital of a society
		Alleviating financial strain through reductions in treatment costs
		Reducing insurance costs
		Increase in gross national product

3.1. Findings from the Axial Coding Paradigm

In terms of acquiring and identifying the main category, which is central to forming the paradigmatic model and organizing related elements, it should be noted that the researcher aimed to develop a theory based on data reflecting the true characteristics of the primary phenomenon—specifically, the design of a safety model for young novice drivers. Key informants who possessed valuable experiences relevant to the research subject were interviewed to inquire about their experiences and attitudes in this regard. During the information collection process, concepts and propositions gradually accumulated until the summary and examination of propositions from the 16th interview led us to identify the main category. Following this, efforts were made to refine and build subsequent questions around it. By the 24th interview, the theoretical saturation of the data was somewhat established. However, interviews continued until the final one to ensure completeness and address conceptual gaps in the model.

Finally, the categories were organized into seventeen main categories, structured within the six of the paradigm model: causal factors (three categories), the main category (three categories), strategies (two categories), contextual factors (three categories), environmental conditions (three categories), and consequences (three categories). Details can be seen in Figure 2 and Table 1.

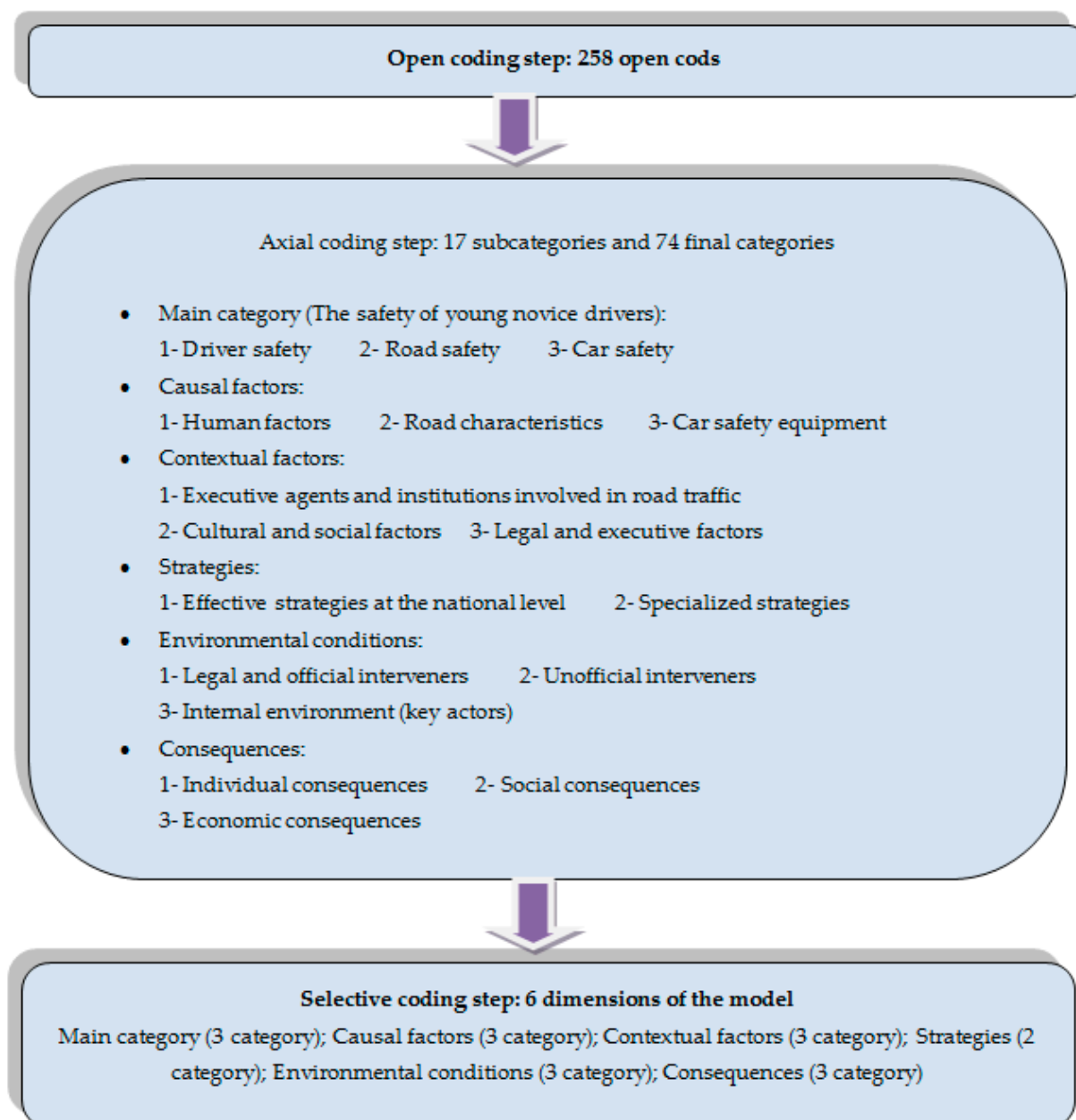


Figure 2. Data management process and model evolution in three stages of coding.

3.1.1. Main Category

The main category in the current study is the safety of young novice drivers, with the following related subcategories:

- The open codes related to the “driver safety” subcategory are fastening the seat belt while driving; observing the speed limit while driving; observing a safe distance while driving (longitudinal and transverse distance); paying attention to the surroundings while driving; and avoiding emotional behaviors.
- The open codes related to the “road safety” subcategory are compliance with road engineering and safety principles in road design (according to standards); use of standard signs on roads; and appropriate geometric design of the roads.
- The open codes related to the “car safety” subcategory are checking the car before driving (tire inflation, engine oil, etc.); compliance with standards in car manufacturing; car safety in terms of pillar, roof, and brake safety; and car safety from the point of view of mechanical engineering in car manufacturing companies.

Regarding the main category of this study, one of the interviewees believed the following: “You see, whenever we want to design and implement a road, we must first have a solution for its safety. This safety includes people, roads, and cars. For example, in the design of arches, the arch must meet specific design standards. If the design speed is 90 km/h, the arch must ensure safety at that speed. Additionally, if there is a transverse slope on the road, it must be properly designed to protect both the safety and comfort of vehicle movement by neutralizing the centrifugal force when a vehicle enters the curve. More than 80% to 90% of safety issues are related to human factors. The primary cause of most crashes is human error. Another important factor is the vehicle itself; it must be of good quality, equipped with well-functioning brakes and properly treaded tires. Additionally, the condition of the road and related weather conditions play a significant role. For instance, the probability of a crash increases in rainy, snowy, or icy conditions.”

3.1.2. Causal Factors

The causal factors in the current study are as follows, with the following related subcategories:

- The open codes related to the “human factors” subcategory are the use of safety equipment while driving; experience and skills of young novice drivers; the skill of young novice drivers in momentary decisions; no use of stimulants or distractions (such as mobile phones, eating and drinking, drugs, etc.); and sufficient training and experience in driving on intercity roads.
- The open codes related to the “road characteristics” subcategory are compliance with the necessary standards in road construction; no potholes on the road; the right screws; good viewing angle for the driver; and safe design of intersections and interchanges.
- The open codes related to the “car safety equipment” subcategory are appropriate design and compliance with standards in the car; observance of safety tips in car braking; having airbags, and equipping the car with other safety equipment.

One of the interviewees in the field of causal factors in the current study, referring to the three factors—human, road, and car—stated the following:

“Crashes can be prevented by improving driving culture and increasing driving experience. One of the components of improving driving culture is compliance with traffic laws and regulations. By observing these regulations as much as possible, unsafe and dangerous behaviors can be avoided. Additionally, experience plays a crucial role in driving, although crashes are not solely governed by specific laws. Therefore, it is advisable to undergo extensive training and gain experience before obtaining a full license. Also, the role of road conditions and car safety in crashes is undeniable. However, in discussions of safety, they are often placed lower in priority. Nevertheless, the safety of these factors can have significant psychological effects on drivers.”

3.1.3. Contextual Factors

Contextual factors refer to elements that directly influence the safety process of young novice drivers. Any changes in these factors will directly impact the main category, strategies, and consequences. The contextual factors in the current study are listed below, along with their related subcategories:

- The open codes related to the subcategory “executive agents and institutions involved in road traffic” are traffic engineering; road engineering; and car production.
- The open codes related to the subcategory “cultural and social factors” are society and culture; family institutions; social networks; and communication networks such as radio and television.
- The open codes related to the subcategory “legal and executive factors” are providing the necessary training to young novice drivers by the traffic department; enhancement of roads by the Ministry of Roads and Urban Development; and the enactment of preventive laws and their proper implementation by the legislative, judicial, and executive powers.

Regarding this, one of the interviewees stated, “In today’s era, we should shift the discussion of traffic crash control and monitoring towards intelligentization. Using up-to-date and smart technologies, it is possible to prevent most violations and traffic crashes. For example, a driver in a city with poor traffic control facilities may be indifferent to red lights or traffic signs. However, when the same driver travels to a city with strong driving control facilities, especially intelligent control, they become law-abiding and fully disciplined. Why? Because they know they are being controlled and monitored in that city. There are cameras and smart systems that monitor his traffic behavior and driving habits. Considering this, it can be concluded that the presence of these conditions causes this change.”

3.1.4. Strategies

According to the findings, although the main category is influenced by contextual factors and environmental conditions, the role of strategies cannot be ignored. They facilitate the process of leading the main category to its consequences through their interventions. In this study, two basic intervention strategies were identified:

- “Effective strategies at the national level” involve policy-making institutions in road safety, such as the Ministry of Roads and Urban Development and its subordinate organizations. The related open codes are appropriate budget allocation for securing cars and roads; applying fines and dealing with risky driving behaviors; using of incentives for safe driving; and training and using educational communication tools.
- Also, a series of strategies within the subcategory of “specialized strategies” was determined. The related open codes are securing roads by installing appropriate traffic signs; improving driver safety by enhancing individual driving skills; extending the duration of driving trainings and utilizing up-to-date technologies in driver training; monitoring, controlling, and managing the false emotions of young novice drivers; and encouraging compliance with traffic laws through relevant institutions.

One of the interviewees expressed the following beliefs:

“Training is the most important initial action to reduce traffic crashes, especially for young novice drivers. Of course, this training must be completed before obtaining a full driver’s license. For example, in addition to teaching driving skills, young novice drivers should be taught not to drive fast, avoid anything that distracts them while driving, not to drive when they feel sleepy or in pain, and to wear their seat belts while driving. They should also pay attention to weather announcements, keep a safe distance, and not drive aggressively. Also, culture building to comply with traffic laws by relevant organizations and NGOs is very effective in reducing traffic crashes. Additionally, young novice drivers naturally experience a range of false emotions due to their age and tend to drive at high speeds. These false and destructive emotions should be controlled. For example, special driving tracks can be built where young drivers can drive at high speeds and safely discharge their emotions.”

3.1.5. Environmental Conditions (Intervening Factors)

The safety of young novice drivers is achieved under specific environmental conditions. Unlike contextual factors, these environmental conditions have a mediating effect on the main category through strategies. The environmental conditions in the current study are listed below, along with their related subcategories:

- The term “legal and official interveners” refers to formal, authoritative bodies or institutions that are legally mandated and responsible for enforcing road safety policies and regulations. These entities have recognized legal authority to implement and regulate measures that directly impact road safety. The open codes related to this subcategory are the executive branch; the legislative branch; the judicial branch; the Ministry of Roads and Urban Development; traffic police; municipalities, and social institutions.
- “Unofficial interveners”, on the other hand, encompass factors that indirectly influence road safety but are not legally bound to do so or may not have formal authority.

These interveners often include social, political, economic, and cultural influences that impact driving behavior, road infrastructure, or the implementation of traffic safety policies. The open codes related to this subcategory are political and legal factors (non-implementation or incomplete implementation of traffic laws); economic factors (lack of sufficient funds in the fields of road construction and traffic improvement and the production of low-quality cars); cultural factors (having the wrong culture of driving and lack of proper training and culture); and social factors (lack of appropriate social media and communication and lack of social contexts necessary for safe driving).

- The open codes related to the subcategory “internal environment (key actors)” are development of information and communication technology; knowledge of driving culture (becoming a scientist); having strategic thinking about the effective factors in traffic safety; development of effective social networks; paying attention to the wishes and expectations of different people in the community; and gradual increase in the number of actors and stakeholders in traffic safety.

In this regard, one of the interviewees stated, “Environmental factors, including executive, judicial, and legislative forces and their components, are effective in ensuring driver safety. Also, by engaging in activities such as media advertising or teaching people to follow traffic rules from a young age, we can help improve road safety. Another issue is the economic cost of enhancing the quality and efficiency of transportation systems, such as roads and vehicles. In my opinion, these should not be seen as mere costs but rather as investments that will improve safety and public health in society.”

3.1.6. Consequences

If the factors and conditions mentioned in the model work well, achievements and positive consequences are expected. In this study, these results are classified into three general subcategories, which include the following:

- The open codes related to the subcategory “individual consequences” are reducing crashes; reducing youth mortality; creating mental peace in drivers; reducing bereaved families; and having a strong and safe generation in the field of safe transportation.
- The open codes related to the subcategory “social consequences” are preventing the wastage of the country’s young talents; reducing the breakdown of families; having a dynamic and lively society and increasing life expectancy in the country; and institutionalizing the culture of following traffic rules from the moment of obtaining a driver’s license.
- The open codes related to the subcategory “economic consequences” are reducing costs for the individual and society; preventing the loss of human resources as the greatest capital of a society; alleviating financial strain through reductions in treatment costs; reducing insurance costs; and increasing gross national product.

The reduction of road crashes and the resulting casualties was one of the key consequences emphasized in the discussions about improving the safety of young novice drivers, as acknowledged by nearly all interviewees. For example, one of the interviewees said, “Any crash that happens incurs high costs and damages. This issue is particularly significant for teenagers and young people. A young person has reached this age after years of upbringing in the family, school, and university environments, and if they lose their life or suffer a disability due to a crash, society will be deprived of such a useful individual. Additionally, crashes involving young drivers cause a lot of personal and social damage, leading to grief for families, the disintegration of the country’s young workforce, and a loss of productivity in society. In this regard, if the responsible organizations fulfill their duties regarding road safety properly and a proper culture is created in society, crashes will decrease, resulting in a dynamic and lively society. By creating mental peace for drivers, the young section of society will be preserved, and life expectancy will increase.”

In this regard, another interviewee stated, “If traffic rules are followed and special attention is paid to road safety by officials and drivers, the number of crashes, deaths, and casualties will be reduced. This will also lower the irreparable costs of these crashes for

individuals and society and prevent the loss of human resources, which are the greatest spiritual capital of a society. Additionally, one of the main factors in a country's progress is its young workforce. The more we can protect their lives in crashes, the faster the country will progress and develop, leading to more favorable development indicators."

4. Paradigm Model for the Safety of Young Novice Drivers

The components of the administrative and institutional system, legal and electronic, and environmental interactions, along with contextual factors (both general and specialized contexts), lead informants and experts to focus on the driving safety of young novices. Of course, in addition to these factors, strategies at both micro and macro levels are necessary to enhance performance in this area. The design of these strategies is also influenced by the environment, which affects the safety of young novice drivers. Finally, as a result of these actions and reactions, we observe the safety of young novice drivers, which has individual, social, and economic consequences.

Based on the provided explanations, the paradigm model of young novice drivers' safety is presented in Figure 3. It shows the factors and components involved in the safety process of young novice drivers and the relationships between them.

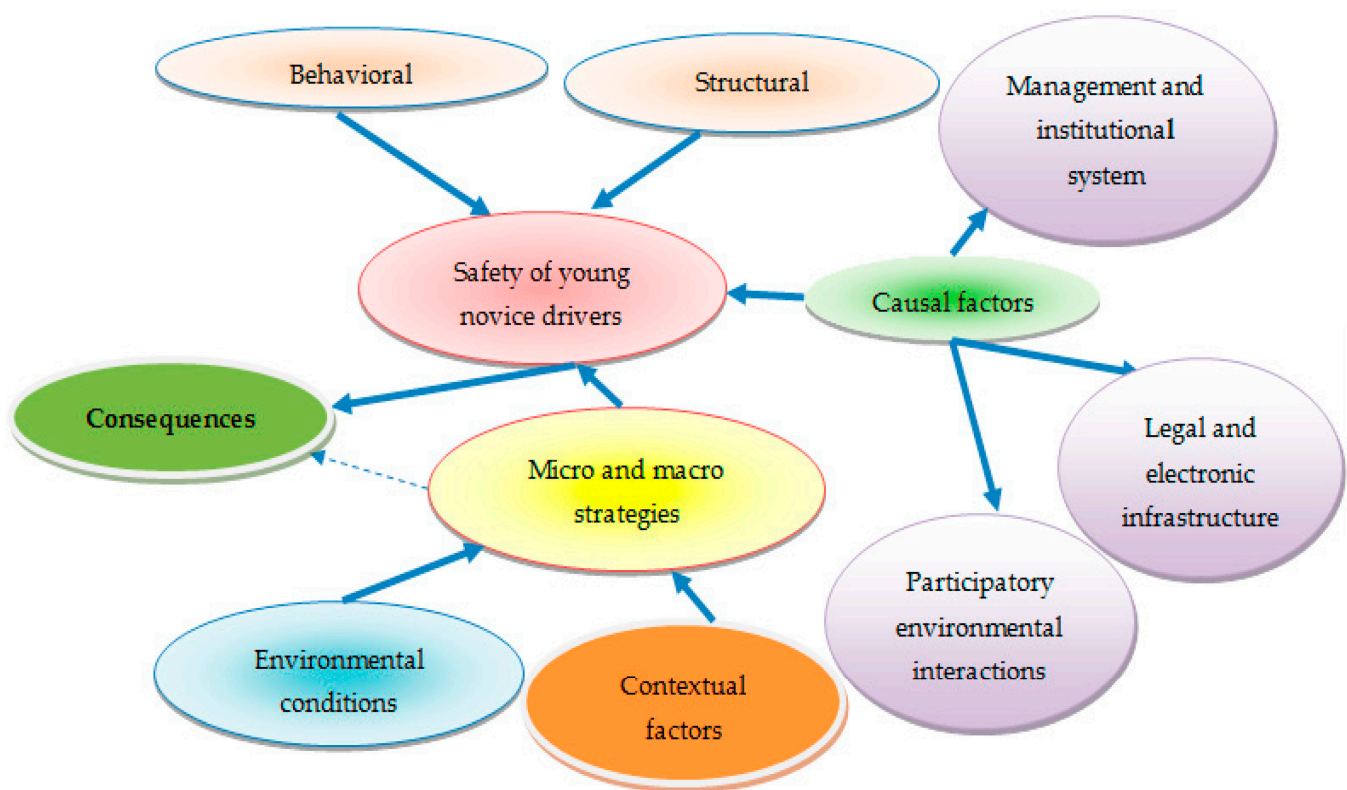


Figure 3. Conceptual model of the relationships between safety components of young novice drivers and their consequences.

Therefore, based on the narrative statement, the components identified during the paradigms of axial and selective coding, along with the relationships between them, can be summarized in the following proposition:

- The management and institutional system, legal and electronic infrastructure, and participatory environmental interactions are the causal factors for the safety of young novice drivers.
- Micro-level and macro-level strategies are essential to achieving the safety of young novice drivers.
- The general and specialized contexts offer a framework based on expert opinions to ensure the safety of young novice drivers.

- External (formal and informal) and internal environmental conditions create a general background—conditions that influence the society, its culture, and the organization—for the safety strategies of young novice drivers.
- The safety of young novice drivers is influenced by causal factors, contextual factors, strategies, and environmental conditions, leading to personal, social, and economic consequences.

The above propositions reflect the relationships between variables affecting the safety of young novice drivers. These propositions are initial claims about the relationships between the components of the research model, which will be tested and either confirmed or rejected in future quantitative studies.

Based on the findings of the paradigm model and the aforementioned propositions, the conceptual model presented in Figure 3 is designed as the primary model of the research. The conceptual model illustrates the relationships between the main categories that emerged from the qualitative analysis process. Based on this model, the safety of young novice drivers is influenced by causal factors (management and institutional systems, legal and electronic infrastructure, and participatory environmental interactions), contextual factors (general and specialized contexts), and strategies (micro and macro). Environmental conditions (external and internal), in turn, affect these strategies. Finally, as a result of the safety of young novice drivers, individual, social, and economic consequences are observed.

5. Discussion

This study seeks to understand the complex interplay of factors affecting the safety of young novice drivers in Iran, a developing country with a significant young population. Using a qualitative approach based on grounded theory, this research identifies the critical components of a model designed to increase the safety of this vital demographic. The model includes categories focusing on driver safety, road safety, and car safety. In addition, it considers the role of causal factors, contextual factors, strategies, environmental conditions, and consequences. This study's findings call to attention the multifaceted character of road safety problems involving young novice drivers. The classification of factors in this study is in line with the existing research that has highlighted the necessity of multi-dimensional approaches in order to fully comprehend and enhance the safety of roads.

5.1. Main Category: Driver Safety, Road Safety, Car Safety

The main categories in this study include driver safety, road safety, and car safety, as a basis for understanding the complexities of young novice drivers' behavior. The two main causes of excessive crashes among young novice drivers are a lack of higher-order driving skills due to insufficient driving experience and risk-taking tendencies due to young age [60]. These cases are consistent with the open codes extracted for driver safety in this study, such as paying attention to the surroundings while driving, driving speed, and emotional behaviors. Studies have also emphasized the relationship between impression management and risky driving behaviors [61]. Also, based on the findings of this study, road safety measures, such as appropriate geometric road design, quality and maintenance of road infrastructure, and the use of standard signs, play an important role in reducing the risk of crashes. These findings are consistent with those of [62], who acknowledged that poor road maintenance and inadequate signage can significantly increase the risk of crashes, especially for inexperienced drivers. Car safety, including compliance with manufacturing standards and mechanical engineering, is another subcategory related to the main category. Research shows that incorporating safety features into cars actually enables them to reduce the severity of crashes [63].

5.2. Causal Factors: Human Factors, Road Characteristics, Car Safety Equipment

The causal factors identified in this study are human factors, road characteristics, and car safety equipment. The identification of human factors, road characteristics, and car safety equipment as causes of crashes involving young novice drivers is in line with the

literature. Human-related factors, such as risk perception, driving experience, and attitudes toward driving, are major contributors to unsafe driving behaviors [64]. In the study of [65], the training of non-professional drivers to improve safety in urban networks is emphasized, which is consistent with one of the open codes of this study. Also, the design, visibility, and maintenance of roads are also important factors, as poor road conditions may lead to an increase in crash rates [66]. Car safety equipment, such as effective braking systems and the installation of features like airbags, represents another subcategory related to the causal factors examined in this study. The introduction of the safety technologies that are present in cars, such as electronic stability control, anti-lock braking systems, and driver assistance systems, has been proven to reduce the chance of young novice drivers being involved in road crashes [67]. The use of advanced technologies in vehicles controlled by young novice drivers can drastically increase road safety, as this study has shown. Nevertheless, in developing countries like Iran, the availability and correct use of such safety features are often limited, which necessitates the implementation of targeted interventions to improve car safety standards.

5.3. Contextual Factors: Executive Agents and Institutions Involved in Road Traffic, Cultural and Social Factors, Legal and Executive Factors

Based on the results obtained in this study, contextual factors such as executive agents, cultural and social factors, and legal factors are major influences on the functioning and efficiency of road safety measures. Factors involved in road construction, road traffic, and car production are among the key elements and mechanisms affecting road traffic. Safety on the roads in Iran is often undermined by the dispersion of authority among many institutions, which results in various agencies each implementing their own policies [66]. By emphasizing collaboration among the respective road safety agencies in Iran, it can be shown that there is a possibility of improving the institutional structures, which are already established and are in need of strengthening. The long-term perspective of safety stakeholders such as the government, non-governmental organizations, and communities amply supports this, suggesting that improvements in road safety can only result from their sustained involvement in inclusive policies and strategies [68]. According to the findings of this study, cultural and social factors significantly influence young novice drivers' behavior and attitudes towards road safety. In this regard, the conducted studies also emphasize the relationship between the socio-cultural status and income of society and the frequency of risky driving behaviors among young novice drivers and their crash rates [23]. In line with the findings of this study, the effects of parental vigilant care and feedback on novice driver risk have been investigated by [24]. Based on the findings of this study, it is suggested that parents be trained to provide effective and vigilant guidance and warnings to young drivers when risky behaviors occur so they can take appropriate action when necessary. Our study underlines the importance of cultural and social influences on the driving behavior of young beginner drivers in Iran and points to the necessity of culturally sensitive interventions from society, families, and social networks in order to promote road safety. This study suggests that legal and executive agents can be instrumental in improving road safety by providing necessary training to young drivers, enhancing road conditions, and enacting laws to prevent risky driving behaviors. It has been found that the implementation of traffic laws can lower the number of crashes and risky driving behaviors of young novice drivers [69]. The findings of this study are also directed to this issue and emphasize the need to enact and enforce traffic laws in Iran.

5.4. Strategies: Strategies at the National Level, Specialized Strategies

It is necessary to develop effective strategies at the national level and specialized strategies to improve the safety of young novice drivers. According to the findings of this study, national strategies should focus on programs such as appropriate budget allocation for securing cars and roads, applying fines and addressing risky driving, using incentives for safe driving, providing training, and employing educational communication tools. All

these results back up the findings of studies that cite the importance of developing a strong road safety strategy through means such as the construction of road infrastructure, the provision of a driver education program, and the implementation of safety standards [70]. Additionally, based on the findings of this study, implementing specialized strategies—such as increasing certification procedures, utilizing up-to-date technologies in driver training and monitoring, and managing the false emotions of young novice drivers—are effective in improving their safety and reducing crashes. In line with the findings of this study, other studies have emphasized that increasing the duration of driver training is effective in reducing crashes among young novice drivers [71]. Also, many studies show that young novice drivers quickly learn basic car control skills, but it takes more time for them to become experts in hazard perception [72,73]. Hazard perception is the ability to predict road hazards and traffic conditions [74]. Therefore, extending the duration of driving training and incorporating up-to-date technologies can strengthen their hazard perception skills. This outcome aligns with the strategies presented in this study.

5.5. Environmental Conditions: Legal and Official Interveners, Unofficial Interveners, Internal Environment

The environmental conditions that are applied in the study of this subject, legal and official interveners, unofficial interveners, and the internal environment are the factors that have a major effect on the driving behaviors of young novice drivers. Legal and official interveners, usually the case police and courts, are highly important in the execution of road safety laws and regulations [75]. Nevertheless, the usefulness of the above-mentioned interventions is often restricted by causes like the absence of resources and corruption. Meanwhile, informal interveners, such as non-governmental organizations and social groups, can be effective in improving road safety by raising awareness and fostering a safety culture [51]. Young novice drivers' safety has been a serious issue in traffic safety. Their driving behavior and crash rates are affected by various factors. The actors examined in this study are the development of information and communication technology and the gradual increase in stakeholders in traffic safety. They play a crucial role in the driving culture and safety outcomes for this demographic. In line with the findings of this study, it appears that ICT tools, including telematics, mobile phone apps, and advanced driver assistance systems (ADASs), are very significant in the improvement of the safety of drivers, especially young novice drivers.

5.6. Consequences: Individual, Social, Economic

According to the findings of this study, the risky driving behaviors of young novice drivers are far from being merely a personal problem, as they endanger society as a whole and harm the economy. In line with the results of this study and the findings of [76], young novice drivers pose a significant threat at the individual level, contributing to injuries and fatalities in traffic accidents, which can ultimately result in long-term physical, psychological, and financial problems. Also, according to the findings of [77], road traffic injuries among young novice drivers place a heavy burden on individuals, families, and society, leading to emotional distress and economic challenges. The results of these studies are consistent with this study's findings, particularly in reducing the number of bereaved families and preventing the loss of the country's young talents through improved safety measures for young novice drivers. Based on this study and the findings of others, the high incidence of road crashes among young novice drivers significantly contributes to the economic costs for society, particularly in developing countries [78]. These findings are consistent with the study's economic consequences, such as reducing costs for individuals and society and alleviating financial strain through decreases in treatment expenses. Therefore, trying to reduce road crashes of young novice drivers and improve road safety, besides being a basic public health priority, is a necessary task with individual, social, and economic consequences.

6. Conclusions

This study aimed to come up with a full road safety model for the most challenging youngest drivers in Iran, who have a big portion of young people. The research came to be after applying the qualitative method suggested by Strauss and Corbin, consisting of semi-structured interviews with road safety professionals that have given the best results in terms of paralleling the two safe driving behaviors to each other. The research also came up with six main key dimensions in the paradigm model: main category, causal factors, contextual factors, strategies, environmental conditions, and consequences, with each of them split into further subcategories.

The safety problems associated with young novice drivers, as well as the fact that risky driving can be influenced not only by individual behavior but also by the surrounding context, are addressed in this paper. As a result, the safety model developed in this study provides a comprehensive framework for understanding and addressing the factors that contribute to the safety of young novice drivers in Iran. Also, this study extends previous research by offering a theoretical framework that integrates the specific contextual factors of developing countries and contributes to a deeper understanding of young novice drivers' safety challenges. This study's outcomes can be a starting point for transportation policymakers to obtain a thorough knowledge of the safety of young novice drivers in the real world and to choose the right policies to improve safety and decrease the probability of road crashes. Improving the safety of young novice drivers is directly connected to achieving broader sustainability goals, as it reduces the economic and social costs associated with road crashes. By promoting safer driving practices and protecting young lives, these efforts contribute to the long-term sustainability of communities by preserving human capital, improving public health, and fostering safer urban environments.

7. Limitations and Future Research

The data collection tool in the present study was a semi-structured interview. Correspondence was made with 75 road safety specialists and experts via email; 54 agreed to be interviewed, and ultimately, 36 were interviewed. Some experts were political or military figures, making them difficult to access, and thus, interviews with some of them were not realized. Since these individuals likely have valuable information and viewpoints in the field, future research could benefit from interviewing them by allocating more time and effort to follow-up. As mentioned, the data collection tool in the current study was a semi-structured interview. Semi-structured interviews provide a means to maintain coherence while covering the concepts raised during an interview. However, there is always a concern in these types of interviews about whether all the issues related to the subject have been addressed with the interviewee. Sometimes, participants have important topics they want to discuss, but if the researcher does not ask about them, the participants may think the researchers are not interested in those topics. For this reason, some researchers believe that conducting interviews in an unstructured way provides richer sources of data for presenting theories [79]. Future researchers could use unstructured interviews on the topic under study. This approach may better achieve the goals of grounded theory.

Another salient point in this regard is the qualitative nature of the research, which, though very elaborate, may not be generalized to other developing countries with different socio-economic and cultural backgrounds. The discrepancy of distant contexts may be accounted for in future research by either applying the model to a different context or using a mixed method of quantitative data to validate and extend the findings. Moreover, the concentration on expert interviews signified that the opinions of young novice drivers themselves were not directly considered. Future studies should not exclude these aspects as they are necessary in order to achieve a more complete picture of the safety of young novice drivers.

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