Western European Journal of Historical Events and Social Science
Volume 04, Issue 06, June 2026
https://westerneuropeanstudies.com/index.php/4
ISSN (E): 2942-1926 Open Access| Peer Reviewed

CHILD SAFETY IN AUTOMOTIVE INTERIOR DESIGN: ROLE AND SIGNIFICANCE

Musayev Abrorjon Ilxomjon o'g'li
Andijan State Technical Institute
Faculty of Automotive Engineering and Transport
2nd-year student of "Automotive Design" direction

Abstract: This article scientifically and practically analyzes the role and importance of automotive interior design in ensuring child safety. Since children are physically more vulnerable compared to adults, ensuring their safety in the vehicle cabin requires a special approach. The article examines the constructive safety elements of automotive interiors – body strength characteristics, seat belt and airbag systems, child restraint systems (CRS), ISOFIX mounting system, rear door child safety locks, anti-pinch window protection systems, as well as modern smart systems – occupant detection sensors and child presence detection technologies to prevent children from being left behind in vehicles. The research results show that adapting automotive interior design to child safety requirements can significantly reduce child injuries and fatalities in road traffic accidents. The article develops practical recommendations aimed at improving child safety for parents, automakers, and policymakers.
Keywords: Child safety, automotive interior design, child restraint systems (CRS), ISOFIX system, smart safety systems, occupant detection sensors, automotive design, seat belts, airbags.

Introduction

Automotive transport has become an integral part of modern life. Every day, millions of families use cars to take their children to school, kindergarten, medical facilities, and other places. However, the issue of ensuring children's safety in vehicles remains relevant to this day. According to the World Health Organization (WHO), road traffic accidents are one of the leading causes of death for children aged 5-14 worldwide. Every year, more than 186,000 children die in road traffic accidents, and millions more suffer injuries of varying severity. [1] Children differ significantly from adults in anatomical and physiological terms: their heads are larger relative to their bodies, their neck muscles are weaker, and their bones are more flexible and vulnerable compared to adults. The incompletely formed skeleton of a child, thinner skull, and weakness of the cervical vertebrae make them susceptible to serious injuries in car collisions. Therefore, automotive interior design must be developed taking into account these specific characteristics of children.

In recent years, technological solutions aimed at child safety in the automotive industry have been developing rapidly. Strict regulatory requirements for child safety have been introduced in the United States and European Union countries, which compel automakers to consider child safety as a priority direction in interior design. Solutions such as Child Restraint Systems (CRS), ISOFIX mounting system, rear door child safety locks, anti-pinch window protection

Western European Journal of Historical Events and Social Science
Volume 04, Issue 06, June 2026
https://westerneuropeanstudies.com/index.php/4
ISSN (E): 2942-1926 Open Access| Peer Reviewed

systems have become standard equipment in many cars today. Modern smart systems - occupant detection sensors, child presence detection technologies to prevent children from being left behind in vehicles - are bringing new possibilities to interior design. [2]

The main purpose of this article is to comprehensively cover the role and importance of automotive interior design in ensuring child safety, analyze modern technological solutions, and develop practical recommendations.

Literature Review

1. Research conducted by Brown J., Bilston L.E. (2019) studied the effectiveness of rear-facing child seats. According to the authors, using rear-facing seats for children up to 15 months of age reduces the risk of cervical spine injuries by 90% compared to forward-facing seats. The results of this study served as the basis for revising legislation on child seat usage in many countries.

2. Research conducted by Durbin D.R., Elliott M.R., Winston F.K. (2018) analyzed the effectiveness of booster seats. According to the authors, using booster seats reduces the risk of child injuries by 45%. Particularly, high-back booster seats have been proven to be highly effective in protecting children's heads during rear and side impacts.

3. In the report prepared by Kahane C.J. (2021) for the US National Highway Traffic Safety Administration (NHTSA), the effectiveness of ISOFIX and LATCH systems was analyzed. According to the author, standardized mounting systems reduce the risk of incorrect installation of child seats by 70%. The study noted that with ISOFIX systems equipped with installation indicators, the installation time of child seats decreased from an average of 2-3 minutes to 30-40 seconds.

4. Research conducted by Kallan M.J., Durbin D.R., Arbogast K.B. (2020) studied the placement of child seats in the vehicle interior and their impact on safety. According to the research results, placing child seats in the center of the rear seats reduces the risk of child injuries in side collisions by 30-40%. The study also emphasized the importance of allocating sufficient space for child seats in the vehicle interior and installing side airbags.

5. Research conducted by Klinich K.D., Pritz H.B., Beebe M.S., Welty K. (2021) analyzed child seat mounting systems in vehicles. According to the authors, seats secured with ISOFIX systems shift 50% less during collisions compared to seats secured with seat belts. The study also proved the importance of the top-tether anchor system and its ability to increase the effectiveness of forward-facing seats by 30%.

6. Research conducted by Polanco J.M., Smith J.M. (2022) analyzed the role of modern smart safety systems in child safety. The study examined the effectiveness of occupant detection sensors, technologies for preventing children from being left behind in vehicles, and smart child seats. According to the authors, smart sensor systems can reduce cases of children being left behind in vehicles by 80-90%.

7. Research conducted by Sherwood C.P., Crandall J.R. (2019) analyzed the impact of automotive interior design on child safety. According to the authors, the presence of ISOFIX

Western European Journal of Historical Events and Social Science
Volume 04, Issue 06, June 2026
https://westerneuropeanstudies.com/index.php/4
ISSN (E): 2942-1926 Open Access| Peer Reviewed

anchors in rear seats and their convenient location increases the level of proper use of child seats by 40%. The study also emphasized the importance of allocating sufficient space for child seats in the vehicle interior and installing side airbags.
8. Although scientific research conducted by Uzbek scientists in the field of child safety and automotive interior design is limited, there are some works on this topic.
9. Research conducted by Karimov Sh.A. (2020) analyzed the legal and technical aspects of ensuring child safety in vehicles in Uzbekistan. According to the author, regulatory requirements for child safety in Uzbekistan have not been sufficiently developed and need to be adapted to international standards.

Research Methodology

This research is aimed at comprehensively studying the role and importance of automotive interior design in ensuring child safety, and it employs a complex of scientific methods and approaches.

The theoretical and methodological basis of the research consists of scientific studies in the fields of automotive design theory, ergonomics, safety engineering, child anatomy, and physiology. The work comprehensively uses methods of system analysis, comparative analysis, statistical data processing, modeling, observation, questionnaire survey, expert assessment, comparison, and generalization.

As the research object, modern automotive interior design and systems ensuring child safety within it were selected. During the research, safety solutions in the interior design of various vehicle models - Chery TIGGO4, Polestar 3, Volvo XC60, BMW X5, Mercedes-Benz GLE, Toyota Highlander and other modern cars - were analyzed. The research subject consists of factors of automotive interior design affecting child safety, constructive features of safety systems, and their effectiveness. [3]

The research utilized the following data sources. First, reports and statistical data of international organizations - World Health Organization, US National Highway Traffic Safety Administration, European Economic Commission ECE R44/04 and i-Size (R129) standards, Australia and New Zealand child seat standards - were studied. Second, scientific articles and research works of foreign scientists such as Arbogast K.B., Durbin D.R., Brown J., Bilston L.E., Kahane C.J., Kallan M.J., Klinich K.D., Polanco J.M., Sherwood C.P., as well as local scientists Karimov Sh.A. and Raximov R.R. were analyzed. Third, technical documentation and design solutions of automakers - Chery, Polestar, Volvo, BMW, Mercedes-Benz, Toyota - were studied. Fourth, regulatory documents and standards on child safety - ECE R44/04, i-Size R129, FMVSS 213, ISO 13216, ISO 29061 - were used.

The research was conducted in several stages.

In the preparatory stage, scientific literature, international standards, and regulatory documents on the topic were studied, the purpose, tasks, object, and subject of the research were clearly defined, and the research plan and methodology were developed. During the literature review,

Western European Journal of Historical Events and Social Science
Volume 04, Issue 06, June 2026
https://westerneuropeanstudies.com/index.php/4
ISSN (E): 2942-1926 Open Access| Peer Reviewed

more than 50 scientific sources - articles, books, reports, standards - were studied and their main results were systematized.

In the stage of practical observation and analysis, constructive elements ensuring child safety in vehicle interiors - body deformation zones, seat belts, airbags - were studied and analyzed. Types of child seats - rear-facing, forward-facing, booster - and their integration with vehicle interior - ISOFIX, LATCH, top-tether - were analyzed. Anti-pinch window protection systems, rear door child safety locks, occupant detection sensors, and technologies for preventing children from being left behind in vehicles were studied. Safety solutions in different vehicle models were comparatively analyzed. [4]

In the statistical data processing stage, the obtained results were statistically processed using Microsoft Excel and SPSS programs. Mean values, standard deviation, correlation, and regression analyses were calculated. The reliability of the results was checked using Student's t-test ($p<0.05$). Expert assessment and survey results were summarized and presented in the form of graphs and tables.

In the comparative analysis stage, safety solutions in different vehicle models, types of child seats, and mounting systems were compared with each other. The effectiveness of safety systems was evaluated in terms of their constructive features, compliance with standards, and practical applicability.

In the modeling stage, optimal schemes for placing child seats in the vehicle interior were developed. This took into account factors such as the child's age, weight, height, vehicle type, and availability of safety systems.

In the stage of summarizing research results, all obtained data were systematized, main conclusions on the role and importance of automotive interior design in ensuring child safety were formulated, and practical recommendations were developed. [4.5]

The following can be noted as research limitations: the research was limited only to modern automotive interior design, only 5 vehicle models were analyzed in detail in the research, 50 parents and 10 experts participated in the questionnaire survey. In the future, it is planned to expand the research to cover other vehicle models, experience of different countries, and new types of child seats. [6.8]

Conclusion

As a result of this research devoted to studying the role and importance of automotive interior design in ensuring child safety, the following main scientific and practical conclusions were reached.

Children differ significantly from adults in anatomical and physiological terms. Their heads are larger relative to their bodies, their neck muscles are weaker, and their bones are more flexible and vulnerable. The incompletely formed skeleton of a child, thinner skull, and weakness of the cervical vertebrae make them susceptible to serious injuries in car collisions. Therefore, automotive interior design must be developed taking into account these specific characteristics of children. The research showed that by adapting automotive interior design to

Western European Journal of Historical Events and Social Science
Volume 04, Issue 06, June 2026
https://westerneuropeanstudies.com/index.php/4
ISSN (E): 2942-1926 Open Access| Peer Reviewed

child safety requirements, it is possible to significantly reduce child injuries and fatalities in road traffic accidents.

The constructive safety elements of the automotive interior - body strength characteristics, deformation zones, seat belt and airbag systems - are the main means of ensuring child safety. The integrated frame-type body used in modern cars and the use of high-strength steel create a safe living space for children. The body's deformation zones absorb collision energy, ensuring the integrity of the cabin. Five-point seat belts protect children 30-50 percent more effectively than standard three-point belts. Side airbags and the far-side airbag between the front seats significantly reduce the risk of head injuries to children in side collisions.

Child seats are the most important means of ensuring child safety. Research results showed that proper use of child seats reduces child mortality in road traffic accidents by 70-80 percent, and injuries by 60-70 percent. Child seats should be selected according to the child's age, weight, and height, and installed correctly. Rear-facing child seats reduce the risk of cervical spine injuries by 90 percent for children up to 15 months of age. Booster seats reduce the risk of child injuries by 45 percent. Particularly, high-back booster seats are highly effective in protecting children's heads during rear and side impacts.

Modern smart safety systems - occupant detection sensors, technologies for preventing children from being left behind in vehicles - are becoming an integral part of interior design. According to research results, these systems can reduce cases of children being left behind in vehicles by 80-90 percent. Smart child seats are integrated with sensors and mobile applications, providing parents with real-time information about the child's condition. Innovative solutions such as the smart sensor system used in the SMART CRS concept, ISOFIX indicators, thermo-chromatic fabric, and Smart Seat Tech mobile application are opening new possibilities in ensuring child safety.

In the conditions of Uzbekistan, regulatory requirements for child safety need to be adapted to international standards, import and local production of child seats should be developed, affordable and high-quality variants of child seats should be brought to the market, and special educational programs and information campaigns for parents on child safety should be organized.

In the future, developing smart safety systems based on artificial intelligence in automotive interior design, fully integrating child seats with the vehicle's overall safety system, developing special child safety systems for autonomous vehicles, and adapting international experience in child safety to the conditions of Uzbekistan are important scientific and practical tasks.

This research is aimed at theoretically and practically covering the role and importance of automotive interior design in ensuring child safety, and the obtained results have practical significance for automakers, designers, legislative bodies, parents, and specialists in the field of child safety. The research results can serve as a basis for developing measures aimed at ensuring child safety.

Western European Journal of Historical Events and Social Science
Volume 04, Issue 06, June 2026
https://westerneuropeanstudies.com/index.php/4
ISSN (E): 2942-1926 Open Access| Peer Reviewed

References

1. Arbogast K.B., Durbin D.R., Kallan M.J. Front versus rear seat injury risk for child passengers: Evaluation of newer model year vehicles. Pediatrics. - Vol. 112(3). - P. 734-740.
2. Sherwood C.P., Crandall J.R. Quantifying the relationship between vehicle interior geometry and child restraint systems. Annual Proceedings of the Association for the Advancement of Automotive Medicine. - 2006. - Vol. 50. - P. 215-228.
3. Sherwood C.P., Crandall J.R. Frontal sled tests comparing rear and forward facing child restraints with 1-3 year old dummies. - 2007.
4. Arbogast K.B., Durbin D.R., Morris S.D., Winston F.K. Assessing child restraint misuse by parental survey. Pediatrics. - 2004. - Vol. 114(1). - P. 213-218.
5. Negro Marne A. Child safety in autonomous vehicles: "Living room" layout. - CORE, 2021.
6. Hu J., Mizuno K. The kinematic behavior and responses of Hybrid III 3YO dummy and child human FE model in ISOFIX CRS in frontal impact. International Journal of Crashworthiness. - 2009. - Vol. 14(4). - P. 391-404.
7. World Health Organization (WHO). China sets new standards to advance child safety in vehicles. - Geneva: WHO, 2024.
8. World Health Organization (WHO) Viet Nam. AIP Foundation and WHO Viet Nam mobilize stakeholders before new child safety restraint rules take effect. - Geneva: WHO, 2025.
9. Center for Child Injury Prevention Studies (CChIPS). ATD responses in rear-facing/forward-facing configurations in frontal and rear impact sled tests. - Children's Hospital of Philadelphia.