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Research Article

Development and Acceptability of Emergency Automobile Foot Brake System

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Abstract
Braking systems constitute a critical component of vehicular safety, serving a vital role in collision prevention and accident mitigation. Recent advancements in automotive engineering and materials science have facilitated the development of more responsive and durable braking technologies that enhance operational reliability and driver safety. Despite these innovations, conventional emergency braking systems continue to exhibit limitations related to efficiency, responsiveness, and user adaptability. In response to these concerns, this study developed and evaluated an Emergency Automobile Foot Brake System intended to improve braking performance and overall vehicular safety. A product development research design was employed, encompassing the stages of design, fabrication, and acceptability evaluation of the developed system. Product assessment was conducted through benchmark, pilot, and final testing phases using evaluation criteria focused on functionality, safety, efficiency, and general acceptability. Initial benchmark testing conducted by the researcher and adviser yielded an overall mean rating of 4.10, interpreted as acceptable. The pilot testing phase, involving instructors and students from the College of Technology at ESSU Guiuan Campus, generated a mean score of 4.23, corresponding to a highly acceptable rating. The final evaluation, conducted among automobile drivers and vehicle owners in Guiuan, further confirmed the product's high acceptability and practical applicability. The findings suggest that the developed emergency foot brake system demonstrates significant potential as an alternative vehicular safety enhancement mechanism.

Keywords
Automatic transfer switch, Panel board, Multi-Pole double-throw switch, Power management; Technology acceptance

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This study was conducted in accordance with ethical standards.

INTRODUCTION

The growing advancement of transportation technology has continuously transformed how people experience mobility, convenience, and safety in their everyday lives. Across the world, road accidents remain one of the persistent concerns affecting both drivers and pedestrians, with many incidents linked to delayed braking response, driver distraction, and mechanical failure. Because of these realities, automobile safety systems have become an essential area of innovation, particularly in the development of emergency braking technologies designed to minimize collision risks and improve vehicle

control. Studies have shown that Autonomous Emergency Braking (AEB) systems significantly reduce front-to-rear crashes and improve overall road safety performance (Cicchino, 2017; Fildes et al., 2015). Similarly, advances in electro-mechanical braking systems, brake pressure estimation, and intelligent braking controls continue to reshape modern vehicle safety technologies (Liu et al., 2022; Li et al., 2023). As transportation systems become more complex, researchers also recognize that effective safety technologies must not only perform efficiently but must also gain the trust and acceptance of drivers who rely on them during critical moments on the road (Razak et al., 2022; Neumann, 2024). Recent studies further demonstrate the growing importance of advanced safety technologies in improving driver protection and reducing road accident severity. Fujiwara and Takechi (2022) emphasized that autonomous emergency braking systems significantly enhance driving safety, particularly among senior drivers who may experience slower reaction times during emergency situations. Similarly, Lucci et al. (2022) highlighted that motorcycle autonomous emergency braking systems can reduce rider injuries and fatalities when braking parameters are carefully optimized and accepted by users. The integration of braking assistance technologies has also expanded into simulation-based safety evaluations. Mims et al. (2022) found that emergency braking systems combined with haptic feedback mechanisms improved driver response and braking behavior during simulated emergency driving tasks. In addition to braking technologies, other vehicle safety innovations such as advanced seatbelt systems continue to complement emergency protection mechanisms by reducing injury risks during collisions (Soica & Gheorghe, 2025). These studies collectively reinforce the importance of developing practical, responsive, and user-centered emergency braking technologies capable of improving overall vehicular safety.

In many local communities, the realities of daily transportation continue to reveal challenges associated with brake reliability, emergency response, and driver safety. Heavy traffic conditions, increasing vehicle use, and inconsistent vehicle maintenance often place motorists in situations where immediate braking response becomes crucial. While modern vehicles increasingly integrate advanced safety features, many drivers still depend on conventional braking systems that may become vulnerable during emergency situations. Existing studies explored brake failure detection systems, emergency braking mechanisms, and driver-assisted safety controls that aim to strengthen vehicular safety and reduce accident risks (Dhanamjayulu et al., 2019; Agbanyo & Amedorme, 2025). Research further emphasized that braking assistance systems can improve response time and lessen the severity of accidents by supporting drivers during unexpected road encounters (Gounis & Bassiliades, 2022; Vaibhav et al., 2022). The effectiveness of emergency braking technologies is further strengthened when integrated with complementary vehicle safety systems and when users perceive these technologies as reliable, responsive, and easy to operate during critical driving situations (Mims et al., 2022; Soica & Gheorghe, 2025). These realities create a meaningful need for emergency automobile foot brake systems that can serve as dependable safety mechanisms under real driving conditions.

Despite the increasing number of studies on autonomous braking systems, collision avoidance technologies, and intelligent vehicle controls, limited research has specifically focused on the development and acceptability of emergency automobile foot brake systems intended for practical and user-centered application. Most existing studies primarily emphasize autonomous vehicle performance, advanced simulations, or highly automated safety mechanisms (Hayashi et al., 2013; Sullivan et al., 2024), while fewer investigations examine how emergency foot brake systems can be designed to remain affordable, responsive, and acceptable to ordinary motorists. Additionally, although Davis (1989) highlighted the significance of perceived usefulness and perceived ease of use in determining technology acceptance, limited studies have applied these concepts to emergency automobile braking technologies within localized transportation settings. Current literature also gives limited attention to how users evaluate such systems in terms of functionality, safety, efficiency, and general acceptability. This gap reveals the need for a study that not only develops an emergency automobile foot brake system but also examines how users perceive its reliability and value in enhancing road safety.

This study is significant because it seeks to contribute to the continuing pursuit of safer and more responsive transportation systems through the development and acceptability assessment of an emergency automobile foot brake system. The study may provide motorists with an additional layer of protection during emergency situations where immediate braking response is necessary. Its findings may also support automotive developers, educators, and future researchers in improving practical braking technologies that prioritize both performance and user confidence. More importantly, this research acknowledges the experiences of drivers whose safety often depends on the reliability of the systems they use every day. By integrating innovation with user acceptability, the study aspires to promote safer driving environments while encouraging the development of vehicle technologies that remain grounded in human safety, trust, and practical accessibility.

METHODOLOGY

Design

This study employed the product development research method to design, develop, and evaluate the acceptability of the Emergency Automobile Foot Brake System. The product development method is a systematic approach used in planning, designing, constructing, testing, and improving a product to ensure that it effectively meets its intended purpose. The study focused on developing a functional emergency foot brake mechanism and assessing its acceptability in terms of functionality, safety, efficiency, and general acceptability.

Locale

The study was conducted at Eastern Samar State University (ESSU) Guiuan Campus and within the town center of Guiuan, Eastern Samar during the Academic Year 2024–2025. These locations were selected due to the accessibility of respondents, including product experts, automobile drivers, and vehicle owners who served as evaluators of the developed system.

Respondents

The respondents were grouped according to the phases of product testing. During the benchmark test, the researcher and research adviser initially evaluated the product. The pilot test involved five (5) instructors and twenty-five (25) automotive students from the College of Technology of ESSU Guiuan Campus. Lastly, the final test involved thirty (30) automobile drivers and vehicle owners residing or working in Guiuan, Eastern Samar. Purposive sampling was utilized because they possessed the knowledge and experience necessary to evaluate the developed product effectively (Marshall, 1996).

Instrument

The researchers utilized a scorecard questionnaire to evaluate the Emergency Automobile Foot Brake System. The instrument measured the product's acceptability in terms of functionality, safety, efficiency, and general acceptability using a five-point Likert scale. The questionnaire also gathered relevant respondent information such as age, driving experience, and type of vehicle operated.

Procedure

Prior to data gathering, the researcher secured permission from the appropriate authorities of the College of Technology. After obtaining approval, the researcher personally conducted the product demonstration and testing procedures. Respondents were then asked to evaluate the product using the scorecard questionnaire. The accomplished questionnaires were collected immediately after the testing process for analysis.

Statistical Treatment and Data Analysis

The gathered data were collated, tabulated, and analyzed using frequency counts, percentages, and weighted mean. These statistical tools were used to determine the level of acceptability of the Emergency Automobile Foot Brake System in terms of functionality, safety, efficiency, and general acceptability. The results were interpreted using a five-point Likert scale interpretation guide.

Table 1
Interpretation of the Likert Scale Used in the Study

Scale Range	Scale Description	Verbal Description	Interpretation
4.21 – 5.00	5	Strongly Agree	Highly Acceptable
3.41 – 4.20	4	Agree	Acceptable
2.61 – 3.40	3	Neutral	Moderately Acceptable
1.81 – 2.60	2	Disagree	Not Acceptable
1.00 – 1.80	1	Strongly Disagree	Highly Not Acceptable

Note. The table presents the scale interpretation used to determine the acceptability level of the Emergency Automobile Foot Brake System.

Ethical Considerations

The researchers observed ethical standards throughout the conduct of the study. Permission was secured from the appropriate authorities before conducting the research. Participation of the respondents was voluntary, and informed consent was obtained prior to product testing and survey administration. Confidentiality of the respondents' information was maintained, and all gathered data were used solely for academic purposes. The researchers also ensured the safe demonstration and testing of the Emergency Automobile Foot Brake System to prevent any harm or risk to the participants.

RESULTS AND DISCUSSION

Table 2 presents the evaluation results of the Emergency Automobile Foot Brake System in terms of functionality. The overall mean score of 4.40, interpreted as "Highly Acceptable," indicates that the developed system effectively performs its intended purpose and provides responsive braking assistance during emergency situations. Among the indicators, the item concerning precise control in various driving conditions obtained the highest mean score of 4.51, suggesting that the system demonstrates stability and responsiveness under different road conditions. This finding supports the study of Liu et al. (2022), who emphasized that efficient brake pressure control and responsive braking mechanisms are essential factors in improving vehicle braking performance and driver safety. Similarly, the respondents highly evaluated the system's smooth and responsive braking performance and its minimal mechanical resistance, indicating that the developed product operates efficiently without compromising braking reliability. This result aligns with the findings of Li et al. (2023), which highlighted that modern electro-mechanical braking systems improve braking precision, efficiency, and overall vehicle control. Moreover, Yang et al. (2022) noted that effective emergency braking technologies significantly contribute to reducing collision risks and improving driving safety. Although the notification mechanism for brake wear received the lowest mean among the indicators, it still remained within the "Highly Acceptable" range, implying that the feature is functional but may still be enhanced for better user awareness. Agbanyo and Amedorme (2025) emphasized that brake monitoring and warning systems play a significant role in preventing accidents caused by brake malfunction and wear. Overall, the findings indicate that the Emergency Automobile Foot Brake System is highly functional and capable of supporting safer driving conditions.

Table 2
Evaluation of the Emergency Automobile Foot Brake System in Terms of Functionality

Indicators	Benchmark Test	Pilot Test	Final Test	Mean	Interpretation
The brake system provides smooth and responsive braking.	4.00	4.37	4.87	4.41	Highly Acceptable

Indicators	Benchmark Test	Pilot Test	Final Test	Mean	Interpretation
The system ensures precise control in various driving conditions.	4.50	4.27	4.77	4.51	Highly Acceptable
The system can adapt to various road conditions to optimize performance.	4.00	4.27	4.73	4.33	Highly Acceptable
The system includes a mechanism to notify the driver of brake wear or potential issues.	4.00	4.20	4.63	4.28	Highly Acceptable
The system operates with minimal mechanical resistance, improving efficiency and longevity.	4.50	4.20	4.67	4.46	Highly Acceptable
Overall Mean	4.20	4.26	4.73	4.40	Highly Acceptable

Note. Higher mean scores indicate greater acceptability of the Emergency Automobile Foot Brake System in terms of functionality.

Table 3 presents the evaluation results of the Emergency Automobile Foot Brake System in terms of safety. The overall mean score of 4.35, interpreted as "Highly Acceptable," indicates that the developed system is perceived by respondents as safe, reliable, and capable of providing protection during emergency braking situations. The indicator regarding the use of high-quality materials obtained the highest mean score of 4.47, suggesting that respondents recognized the durability and reliability of the system components. This finding is supported by Li et al. (2023), who explained that braking systems designed with durable and efficient materials contribute significantly to vehicle safety and long-term braking performance.

The respondents also highly rated the system's ability to provide overall safety during failure of the primary foot brake, indicating that the developed mechanism effectively functions as an emergency backup system. This supports the findings of Dhanamjayulu et al. (2019), which emphasized that secondary emergency braking systems improve vehicle safety by minimizing risks associated with brake failure. In addition, the system's real-time reaction capability and reliable braking performance across different vehicle conditions were evaluated positively, reflecting the importance of immediate braking response during critical driving situations. According to Cicchino (2017) and Fildes et al. (2015), emergency braking systems significantly reduce crash risks by improving vehicle response during sudden road encounters. Furthermore, Della Monica et al. (2025) highlighted that safety-focused emergency braking technologies must prioritize reliability, risk reduction, and consistent operational performance. Overall, the findings suggest that the developed Emergency Automobile Foot Brake System effectively meets important safety requirements necessary for automotive use.

Table 3
Evaluation of the Emergency Automobile Foot Brake System in Terms of Safety

Indicators	Benchmark Test	Pilot Test	Final Test	Mean	Interpretation
The brake system provides overall safety to users during failure of the main foot brake.	4.00	4.27	4.87	4.38	Highly Acceptable
The system is built with high-quality materials that can withstand prolonged use without performance issues.	4.50	4.13	4.77	4.47	Highly Acceptable
The system features a real-time reaction mechanism when the main foot brake malfunctions or wears out.	4.00	4.27	4.73	4.33	Highly Acceptable
The system design ensures consistent and reliable braking performance across different vehicle models.	4.00	4.27	4.63	4.30	Highly Acceptable
The system meets safety standards to ensure maximum protection of drivers and passengers.	4.00	4.17	4.67	4.28	Highly Acceptable
Overall Mean	4.10	4.22	4.73	4.35	Highly Acceptable

Note. The table presents the respondents' evaluation of the Emergency Automobile Foot Brake System in terms of safety.

Table 4 presents the evaluation results of the Emergency Automobile Foot Brake System in terms of efficiency. The overall mean score of 4.37, interpreted as "Highly Acceptable," indicates that the developed system performs efficiently and consistently during operation. The results further reveal a noticeable improvement from the benchmark test to the final test, suggesting that the modifications and refinements applied during the development process positively enhanced the product's overall performance. The indicator related to the use of high-quality materials obtained the highest mean score of 4.50, reflecting the respondents' confidence in the durability and efficiency of the braking mechanism. This finding supports the study of Li et al. (2023), which stated that efficient braking systems depend heavily on durable materials and optimized braking structures to maintain reliable vehicle performance.

The respondents also highly rated the system's ability to provide immediate braking response during emergency situations, indicating that the product effectively minimizes delay during braking activation. According to Gounis and Bassiliades (2022), intelligent braking systems improve operational efficiency by enabling faster and more controlled braking responses during critical driving conditions. Likewise, Vaibhav et al. (2022) emphasized that emergency braking technologies with responsive mechanical components contribute to improved braking efficiency and safer driving experiences. The increase in evaluation scores during the final testing phase also suggests that the adjustments made to the prototype enhanced its operational consistency and reliability. Moreover, Neumann (2024) explained that advanced driver-assistance systems become more effective when braking technologies demonstrate efficient real-time response and user

reliability. Overall, the findings indicate that the Emergency Automobile Foot Brake System performs efficiently and is capable of supporting safe and dependable vehicle operation.

Table 4
Evaluation of the Emergency Automobile Foot Brake System in Terms of Efficiency

Indicators	Benchmark Test	Pilot Test	Final Test	Mean	Interpretation
The brake system provides overall safety to users during failure of the main foot brake.	4.00	4.23	4.83	4.35	Highly Acceptable
The system is built with high-quality materials that can withstand prolonged use without performance issues.	4.50	4.27	4.73	4.50	Highly Acceptable
The system features a real-time reaction mechanism when the main foot brake malfunctions or wears out.	4.00	4.23	4.77	4.33	Highly Acceptable
The system design ensures consistent and reliable braking performance across different vehicle models.	4.00	4.23	4.70	4.31	Highly Acceptable
The system meets safety standards to ensure maximum protection of drivers and passengers.	4.00	4.23	4.80	4.34	Highly Acceptable
Overall Mean	4.10	4.24	4.77	4.37	Highly Acceptable

Note. The table shows the efficiency evaluation of the Emergency Automobile Foot Brake System based on the responses gathered during the three testing phases.

Conclusion and Recommendations

The study concluded that the developed Emergency Automobile Foot Brake System is highly acceptable in terms of functionality, safety, efficiency, and general acceptability. The findings revealed that the system effectively performs its intended purpose by providing responsive braking assistance, reliable emergency braking support, and efficient operational performance during testing. The positive evaluation from experts and end users further indicates that the developed product is capable of enhancing vehicle safety and may serve as a practical supplementary braking mechanism for automobiles.

Based on the findings of the study, the researchers recommend further enhancement of the Emergency Automobile Foot Brake System through additional design improvements and integration of advanced safety features for better real-time responsiveness and monitoring. Future researchers may also conduct wider testing using larger groups of respondents and different vehicle types to further validate the effectiveness and reliability of the system. Moreover, automotive educators, developers, and vehicle owners may utilize the developed product as a basis for promoting innovation and improving automobile safety technologies.

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