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DEVELOPMENT OF REMOTE CONTROLLED MOTORCYCLE HELMET WIPER

CHRISTIAN JAY B. MACARIO

Capiz State University-Roxas City, Main Campus Philippines

Abstract: This study focused on the design, development, and evaluation of a remote-controlled motorcycle helmet wiper intended to enhance rider visibility and safety during rainy conditions. Specifically, the study aimed to describe the technical features of the device, determine its sensitivity in terms of wiping speed, assess its effectiveness in clearing raindrops under varying rainfall conditions, and evaluate its acceptability in terms of technical features, composition, operating performance, and safety. A developmental research design was employed in the conduct of the study. The developed device consisted of a compact wiper mechanism mounted on the helmet visor and connected to a lightweight 3D-printed housing containing the power supply, rechargeable battery, RF relay receiver, and control circuitry. A flexible spring wire was incorporated to allow smooth visor movement while minimizing strain on electrical connections. The system operated in two modes, slow and continuous, controlled through a handheld wireless remote. The evaluation involved fifty (50) evaluators composed of motorcycle riders, instructors, and individuals with expertise in mechanical, electrical, and safety-related fields. Data were gathered through structured observation, controlled performance testing, and an acceptability evaluation instrument. Results showed that the developed helmet wiper was functionally integrated and suitable for helmet application. In terms of sensitivity, the device recorded an average wiping speed of 30.66 wipes per minute in slow mode and 75 wipes per minute in continuous mode. The device demonstrated effective raindrop removal under light and moderate rainfall in both modes of operation; however, optimal performance during heavy rainfall was observed only when operated in continuous mode. Moreover, the device obtained a “Very Acceptable” rating across all evaluated criteria, indicating positive user perception of its design, durability, operating performance, and safety. Overall, the findings demonstrate that the developed remote-controlled motorcycle helmet wiper is a functional, safe, and user-acceptable safety device with strong potential for practical application in improving rider visibility during adverse weather conditions.

Keywords: Helmet Wiper, Wireless Control, Rider Safety, Visibility Enhancement, Ergonomic Design, Rain Protection, Operational Performance, User Acceptability.

I. INTRODUCTION

Motorcycles have become a prominent mode of transportation, particularly in Asian countries, due to their affordability, fuel efficiency, and convenience in navigating congested urban roads. As noted by Khan and Mia (2020), the growing reliance on motorcycles has made them a practical alternative to private cars and public transportation for daily mobility. However, this increased usage has also been accompanied by a rise in road traffic accidents involving motorcycles. According to Das et al. (2018) reported that motorcycle crashes remain a significant contributor to road-related injuries and fatalities, with head injuries identified as one of the primary causes of severe outcomes.

Motorcycle helmets are designed to protect riders by absorbing impact forces and reducing the risk of head trauma. According to a systematic review cited by Olsen et al. (2016), motorcycle helmet use can reduce the risk of head injury by approximately 69% and the risk of death by about 42%, underscoring their importance as a fundamental safety device. Due to these significant safety benefits, helmet use has been mandated by law in many countries worldwide as part of broader road safety initiatives aimed at protecting motorists and reducing traffic-related fatalities.

One of the most common challenges encountered by motorcycle riders, particularly during rainy conditions, is reduced visibility caused by raindrops accumulating on the helmet visor. Riding in the rain significantly compromises a rider’s visibility, resulting in slower reaction time and an increased likelihood of accidents.

The development of a motorcycle helmet wiper system represents a practical application of technology aimed at enhancing road safety and user protection. The study supports the Sustainable Development Goals (SDGs), particularly SDG 3: Good Health and Well-Being, which aims to reduce deaths and injuries from road traffic accidents, and SDG 9: Industry, Innovation, and Infrastructure, which promotes innovation and the development of resilient technologies. This innovation aligns with the College of Education Research Thrusts and Priorities (2024–2028), particularly Research Area

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No. 8: Techno Transfer, which emphasizes the translation of research outputs into functional, market-ready technologies (Sources: CAPSU VMGO and Research Agenda, NHERA, DOST-HNRDA, DepEd-BERA, and UN-SDGs).

The researcher developed a remote-controlled motorcycle helmet wiper system designed to enhance rider visibility during rainy conditions. The proposed system integrates a compact motorized wiper mechanism with a wireless control interface, allowing riders to activate the wiper without removing their hands from the handlebars. Leveraging recent technological advancements, the system is designed to be lightweight, easy to install, and compatible with various helmet models, thereby supporting compliance with helmet laws while addressing visibility-related safety challenges. Through this development, the study aims to contribute to safer motorcycle operation and the practical application of technology in support of road safety initiatives.

Objectives of the Study

The study aimed to develop a remote-controlled motorcycle helmet wiper designed to enhance rider visibility and safety during rainy conditions. Specifically, this study aimed to:

1. Describe the technical features of the developed remote-controlled motorcycle helmet wiper.
2. Determine the sensitivity of the device in terms of wiping speed.
3. Determine the wiping effectiveness of the device in terms of clearing raindrops under light, moderate and heavy rainfall; and
4. Determine the acceptability of the device in terms of technical features, composition, operating performance, and safety.

II. METHODOLOGY

Prior Art

The study of Stoppa and Chiolerio (2019) explored the use of hydrophobic and anti-fog technologies as a means of improving visibility in transparent surfaces such as helmet visors. Their work focused on advanced material coatings designed to repel water and minimize fog formation, thereby maintaining a clearer field of vision for users operating under varying environmental conditions. These technologies are widely applied in safety equipment where visibility is critical, including protective eyewear and helmet systems. The findings of the study indicated that hydrophobic coatings are effective in reducing water adhesion on surfaces by promoting droplet formation and runoff. Similarly, anti-fog treatments help prevent condensation buildup caused by temperature differences between the inside and outside of the visor. As a result, these passive technologies contribute to improved visibility under light rain and humid conditions, enhancing user safety without requiring mechanical or electronic components.

Methods of Research

This study employed a developmental research design to develop a remote-controlled motorcycle helmet wiper aimed at enhancing rider visibility and safety under varied weather conditions and determining the device's sensitivity and effectiveness. The research was conducted at Capiz State University, Main Campus, Fuentes Drive, Roxas City, starting in December 2023. The development process involved several phases: initial conceptualization, mechanical design, electronic integration, user interface development, and performance optimization. A comprehensive review of existing helmet wiper systems and related technologies was undertaken to inform the design. The prototype was constructed using durable materials and reliable electronic components to ensure operational stability and longevity.

The evaluation phase engaged 50 evaluators, including 15 riders, 15 professors and instructors who own motorcycles, and 20 student motorcycle users, providing diverse perspectives and expertise. Data collection methods was including performance testing under various weather conditions, with feedback collected through surveys and interviews. The study focused on describing the device's technical features, determining its sensitivity in terms of wiping speed, evaluating its effectiveness, and assessing its acceptability in terms of technical features, composition, operating performance, and safety. The study was also ensuring compliance with safety and regulatory standards specific to motorcycle helmets. The findings aimed to contribute to advancements in motorcycle helmet technology, ultimately enhancing rider visibility and safety.

Design Criteria

The remote-controlled motorcycle helmet wiper was designed according to specific criteria that support the study's objectives. To address the technical features of the device, the system was required to include a stable wireless

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control mechanism, a functional wiping motor, and a power-efficient electrical layout that would operate reliably without adding excessive weight to the helmet. In terms of wiping speed sensitivity, the wiper was required to demonstrate consistent responsiveness to user inputs by producing both intermittent and continuous wiping modes with stable timing and no operational delay.

To ensure wiping effectiveness under light, moderate, and heavy rainfall, the wiper blade and mechanism were designed to provide sufficient pressure and motion to clear accumulated raindrops from the visor, thereby improving visibility across varying weather conditions. In consideration of the device's overall acceptability, the system was constructed using lightweight, durable, and weather-resistant materials, ensuring user comfort, operational safety, and seamless integration with the helmet without compromising the rider's field of vision or the helmet's protective function.

Instrumentation

The instruments used in this study consisted of researcher observation, performance measurements, and a structured acceptability questionnaire. Researcher observation and performance measurements were employed to describe the technical features of the device, determine its sensitivity in terms of wiping speed, and evaluate its effectiveness in clearing raindrops under simulated rainfall conditions. These methods involved direct inspection, timed wiping tests, and controlled spray testing to generate objective performance data. A structured questionnaire using a five-point Likert scale was utilized to measure the acceptability of the device in terms of technical features, composition, operating performance, and safety. These instruments ensured that all research objectives were systematically and accurately evaluated.

The acceptability evaluation used a five (5)-point Likert scale, where 5 represented the highest rating and 1 represented the lowest. The evaluation was conducted in the automotive laboratory room. However, for other evaluators such as motorcycle riders and users with extensive road experience, the evaluation was carried out at their respective workplaces to allow them to examine the actual device and receive instructions on its setup and operation.

The evaluation sheet for technical features, operating performance, and safety was scored as follows:

Score	Weighted Mean	Verbal Interpretation
5	4.21 – 5.00	Very Acceptable
4	3.41 – 4.20	Acceptable
3	2.61 – 3.40	Moderately Acceptable
2	1.81 – 2.60	Less Acceptable
1	1.00 – 1.80	Least Acceptable

The wiping speed was quantified by recording the number of wipes per minute for each operating mode. Based on the observed frequency, the device's sensitivity was interpreted using verbal descriptions. A wiping pattern characterized by intermittent motion with noticeable time intervals was classified as slow wiping speed, whereas continuous and frequent motion was classified as fast wiping speed.

This approach enabled the researcher to relate the measured wiping frequency to the device's responsiveness and sensitivity without the need for complex statistical analysis

This binary scale was used to determine whether the device could provide a clear line of sight to the rider, which is the primary indicator of visibility enhancement.

Wiping Speed Interpretation	Descriptions
Slow	Wiping with noticeable delay between cycles
Fast	Continuous wiping with minimal or no delay

Rating	Interpretation	Description
1	Effective	The device successfully improved rider visibility by clearing raindrops in the helmet visor under light, moderate and heavy rainfall.
0	Not Effective	If the device did not improve visibility or failed to clear the visor effectively under light, moderate and heavy rainfall.

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Parameter for Analysis

The data gathered in this study were analyzed according to the objectives of the research. To describe the technical features of the developed remote-controlled motorcycle helmet wiper, the researcher documented its physical composition, materials, placement of components such as the motor and blade, as well as its remote-controlled functionality. This was analyzed descriptively through narrative explanation, photographs to provide a comprehensive understanding of the device's features.

For the evaluation of the device's sensitivity in terms of wiping speed, the performance of the helmet wiper was measured based on the number of wiping cycles completed per minute (wipes/min) under two operating modes: slow wiping mode and continuous mode. Each mode was tested through three trials, and the wiping speed for each trial was recorded.

III. PRESENTATION, ANALYSES, AND INTERPRETATION OF DATA

This chapter presents the key findings of the study. It includes the respondents' evaluations of the developed remote-controlled motorcycle helmet wiper, with a focus on performance, usability, and overall acceptability. The data were analyzed and interpreted to demonstrate how effectively the device meets riders' needs and enhances visibility and safety on the road.

Technical Features of the Development of Remote Controlled Motorcycle Helmet Wiper

This section presents the technical features of the developed remote-controlled motorcycle helmet wiper. The device was designed to enhance rider visibility during rainfall while maintaining helmet comfort and safety. The system consisted of a compact wiper mechanism mounted on the helmet visor and a housing unit positioned at the top of the helmet (Figure 4).

The main housing contained the power supply, charging system, RF relay receiver, and control circuitry. The casing was fabricated using lightweight 3D-printed plastic to minimize additional weight on the helmet. A battery indicator at the rear of the housing allowed the rider to monitor the device's battery status.

The wiper mechanism was connected to the main housing through a flexible spring wire, which enabled smooth movement during visor opening and closing without straining the electrical connections. The motor or servo responsible for the wiping action was mounted on the visor and electrically connected to the power board inside the housing.

The device was operated using a wireless remote control. Pressing the power button activated slow wiping mode with a short delay between wipes. Pressing it again switched the device to continuous wiping mode, and a subsequent press turned the device off. This control scheme allowed the rider to select the appropriate wiping mode based on rainfall intensity.

The wiping assembly consisted of a wiper blade attached to a wiper arm, which was driven by a small motor enclosed in a protective cover. The motor assembly was positioned near the visor to directly control the wiping motion. A flexible spring wire linked the motor to the main component case, allowing smooth transmission of power while maintaining flexibility during visor movement.

The central component case housed the primary electronic parts of the system, including the RF relay receiver and the charging and power board. A charging port was mounted on the side for convenient recharging, while a battery indicator located at the back allowed the rider to monitor the battery status. The antenna mounted on the top cover enhanced wireless signal reception from the remote control.

The system was powered by a 5V rechargeable battery stored separately in a battery storage case attached to a movable base arm. This design helped distribute weight evenly and provided stability when the device was mounted on the helmet. All casing components, including the motor cover, component case, and battery storage case, were designed as lightweight enclosures produced through 3D printing.

A handheld remote equipped with on/off buttons transmits control signals to the RF relay receiver, allowing the rider to operate the wiper system remotely. The exploded view of the device illustrates the interrelationship between the mechanical structure, electronic components, and wireless control system, highlighting how these elements function together as an integrated helmet-mounted wiper solution.

These observations indicate that the technical features of the developed remote-controlled motorcycle helmet wiper provide a robust functional foundation for its operation as a helmet-mounted safety device. The integration of a wireless control system, rechargeable power supply, battery level indicator, flexible spring wire connection, and compact housing demonstrates that the device was designed with usability, adaptability, and rider safety in mind. Collectively, these features enhance the device's reliability under actual riding conditions and establish a basis for further performance evaluation, refinement, and potential future development.

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Sensitivity of the Device in Terms of Wiping Speed

Table 3 presents the evaluation of the developed remote-controlled motorcycle helmet wiper's sensitivity, measured in terms of wiping speed. In this study, sensitivity refers to the device's ability to execute wiping actions quickly and consistently across its defined operating modes, which directly affects user experience and helmet visibility. The results compare Slow Wiping Mode with Continuous Mode, highlighting differences in performance that have implications for the design of wearable control systems.

In Slow Wiping Mode, the device recorded a mean wiping speed of 30.66 wipes/min, classifying it within the "Slow" range (0–30 wipes/min). This low-speed performance is consistent with operational modes where precision, minimal motion disturbances, or energy conservation are prioritized. Slower actuation rates can reduce mechanical wear and extend battery life, an important consideration for portable wearable systems that must balance responsiveness with power efficiency. These findings are supported by Naranjo et al. (2025), who emphasized that slower actuation is sometimes necessary to ensure fine control and stability, particularly to prevent unintended user disturbance or feedback noise in integrated sensor systems.

However, the observed slow wiping speed may limit the device's effectiveness in scenarios requiring rapid adaptation to sudden changes in helmet visibility, such as during heavy rain or when debris impacts the visor. This aligns with the findings of Sun et al. (2025), who reported that responsiveness and actuation speed are critical performance metrics in real-time interactive systems, as insufficient speed can negatively affect perceived usability and task success. In this context, the current study confirms Sun et al.'s assertion, demonstrating that slow wiping modes prioritize energy efficiency and precision over rapid visibility restoration.

Conversely, Continuous Mode exhibited a mean speed of 75 wipes/min, corresponding to the "Fast" category (61–80 wipes/min). This high-speed configuration allows the device to clear the helmet surface more rapidly, maintaining optimal visibility under dynamic conditions. The fast response observed in this study supports Elfouly and Alouani's (2025) findings, which emphasize that higher operational frequencies improve system performance in wearable and wireless monitoring applications.

Nonetheless, elevated speeds introduce potential trade-offs. Fast operation can increase mechanical strain, consume more power, and generate vibrations that may affect user comfort. Naranjo et al. (2025) similarly noted that excessive actuation speeds in wearable devices can compromise ergonomics if not carefully optimized. Therefore, while Continuous Mode demonstrates improved responsiveness, it may require design considerations to mitigate mechanical and ergonomic drawbacks.

The contrasting wiping speed profiles between the two modes suggest important design implications. Device developers should calibrate wiping speeds according to environmental conditions and user expectations. Fast modes provide quick clearing at the potential cost of energy efficiency and mechanical life, whereas slow modes conserve energy but may be less effective under rapidly changing visibility conditions. The classification of wiping speeds into "Slow," "Average," and "Fast" offers a structured metric that can be integrated into broader evaluation frameworks for wearable control systems, aligning with published methodologies in ergonomic and wireless system assessments (Sun et al., 2025).

The study's results largely confirm the literature, demonstrating that actuation speed directly impacts usability, safety, and device performance, while also highlighting the necessary trade-offs between speed, efficiency, and mechanical robustness.

The results indicate that Continuous Mode is more effective in providing rapid response, which is critical for enhancing helmet visibility, while Slow Wiping Mode is better suited for low-intensity applications. These findings are consistent with established trends in wearable control systems, where performance metrics such as speed and sensitivity must be carefully balanced against usability and power efficiency (Elfouly & Alouani, 2025; Naranjo et al., 2025).

This suggests that the developed device exhibits sufficient sensitivity to user commands, offering distinct wiping speed modes that adapt to different riding conditions. The availability of both slow and continuous modes enables controlled operation during light rain or minor debris accumulation and faster response when visibility demands increase. This adaptability confirms Naranjo et al.'s (2025) assertion that multi-level actuation enhances usability in wearable systems, while simultaneously supporting Elfouly and Alouani's (2025) findings on the importance of responsiveness in dynamic, real-time applications.

Overall, the device's ability to adjust its wiping speed according to situational requirements demonstrates its practicality and effectiveness as a helmet-mounted safety accessory, ensuring timely and responsive wiping action that helps maintain rider visibility under varying environmental conditions.

Table 3. Sensitivity of the Device in Terms of Wiping Speed.

Mode	Trials (Wipes/Min)			Mean (Wipes/Min)	Data Interpretation
	1	2	3		
Slow Wiping Mode	30	31	31	30.66	Slow
Continuous Mode	75	75	75	75.0	Fast

Legend*: 61 – 80 wipes/min – "Fast"* *0 – 30 wipes/min – "Slow"*
31 – 60 wipes/min – "Average"

Wiping Effectiveness of the Device in terms of Clearing Raindrops Under Light, Moderate, and Heavy Rainfall

Table 4 presents the effectiveness of the developed remote-controlled motorcycle helmet wiper in clearing raindrops under light, moderate, and heavy rainfall conditions, using both slow and continuous wiping modes. This evaluation is critical in determining the device's ability to maintain visor clarity, which directly impacts rider visibility and safety during rainy riding conditions.

Under light and moderate rainfall, the helmet wiper demonstrated consistent effectiveness across both slow and continuous modes. All trials in these conditions received a total score of 3, verbally interpreted as Effective. This indicates that even at reduced wiping frequency, the device is capable of adequately clearing raindrops and maintaining a clear line of sight. These results are consistent with Çakir (2022), who reported that active clearing mechanisms in rider-assistive visibility systems are generally sufficient to mitigate the impact of light to moderate precipitation. The consistent performance across wiping modes also suggests that excessive wiping speed is unnecessary under these conditions, which can help conserve power and reduce mechanical wear—findings that align with general principles in wearable device design (Naranjo et al., 2025).

In contrast, performance under heavy rainfall varied notably between wiping modes. The slow wiping mode failed to clear raindrops effectively in all trials, receiving a total score of 0 (Not Effective). This indicates that low-frequency wiping is insufficient to handle rapid water accumulation during intense rainfall, confirming the observations of Ullah et al. (2025), who emphasized that heavy rain significantly impairs rider visibility and demands highly responsive clearing mechanisms. Conversely, the continuous wiping mode achieved a total score of 3 (Effective) across all heavy rainfall trials, demonstrating its capability to maintain visor clarity under severe precipitation.

The results reveal that the effectiveness of the helmet wiper is influenced by both rainfall intensity and wiping mode. While slow mode is adequate for light to moderate rain, continuous operation is essential under heavy rainfall to ensure sufficient visibility. These findings suggest potential benefits of implementing adaptive or mode-switching control mechanisms that automatically adjust wiping speed based on rainfall intensity, a strategy supported by prior studies on vehicle visibility systems (Kumar et al., 2025).

The developed remote-controlled motorcycle helmet wiper is functionally effective in improving rider visibility under light to moderate rainfall and remains effective under heavy rainfall when operated in continuous mode. However, its reduced performance in slow mode during heavy rain indicates the need for higher operational responsiveness or adaptive control to maintain consistent visibility in more demanding conditions. These findings confirm the device's contribution to rider safety while identifying clear directions for further design optimization and performance enhancement.

Table 4. Effectiveness of the Developed Remote-Controlled Motorcycle Helmet Wiper in Clearing Raindrops under light, moderate and heavy rainfall.

Rainfall Condition	Wiping Mode	Trial 1	Trial 2	Trial 3	Total Score	Data Interpretation
Light Rain	Slow	1	1	1	3	Effective
	Continuous	1	1	1	3	Effective

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Moderate Rain	Slow	1	1	1	3	Effective
	Continuous	1	1	1	3	Effective
Heavy Rain	Slow	0	0	0	0	Not Effective
	Continuous	1	1	1	3	Effective

Legend*: 1 – "Effective" 0 – "Not Effective"*

Acceptability of the Developed Remote Controlled Motorcycle Helmet Wiper in terms of Technical Features

Table 5 presents the mean ratings and corresponding verbal interpretations of respondents regarding the technical features of the developed remote-controlled motorcycle helmet wiper. These results reflect the extent to which the device meets user expectations in terms of functionality, usability, and system reliability.

Among the evaluated features, the built-in battery level indicator received the highest mean score of 4.96, verbally interpreted as "Very Acceptable." This finding indicates that respondents place high importance on awareness of power status when using wearable safety devices. Being informed of the battery condition enhances user confidence and reduces the risk of unexpected device failure during operation. These results align with previous research by Dias and Cunha (2018) and Zheng et al. (2021), which emphasizes that real-time power feedback improves usability and contributes significantly to overall device acceptance.

Indicators related to user-friendliness of operation and consistency of wiping motion both recorded a mean score of 4.94, also interpreted as "Very Acceptable." These findings suggest that respondents perceived the device as easy to operate while maintaining stable performance during repeated use. Ease of use is particularly important for helmet-mounted devices, as motorcycle riders must maintain focus on the road with minimal cognitive distraction. The consistent mechanical performance of the system further indicates reliability under continuous operation. This is supported by studies on compact mechanical systems, which emphasize that reliable performance is essential for wearable devices to ensure consistent functionality (Singh et al., 2020).

The integration and stability of electronic components received a mean score of 4.88, still within the "Very Acceptable." range. This indicates that respondents observed proper system integration and stable electronic performance during operation. In compact wearable systems, effective integration of electronic components is essential for durability, reliable operation, and safe use under varying environmental conditions. Previous studies on embedded and wearable devices (He et al., 2016; Majumder et al., 2017) similarly report that well-integrated hardware enhances system performance and user acceptance.

The efficiency and responsiveness of the remote-controlled system obtained the lowest mean score of 4.82, yet it remained verbally interpreted as "Very Acceptable." Although ranked lowest among the indicators, this still reflects a reliable response to control inputs with minimal perceived delay. Responsiveness is critical in helmet-mounted safety devices, as delayed activation can compromise visibility and rider safety. These findings are supported by Islam et al. (2019) and Lee and Lee (2020), who highlighted that dependable control response enhances user trust and perceived effectiveness in wearable control systems.

Overall, the grand mean of 4.91, interpreted as "Very Acceptable," demonstrates a high level of acceptability across all evaluated technical features. These results indicate that the developed remote-controlled motorcycle helmet wiper successfully integrates responsive control, stable electronics, consistent mechanical performance, and user-oriented design.

Table 5. Acceptability of the developed remote-controlled motorcycle helmet wiper in terms of technical features.

Statement	Mean	Verbal Interpretation
The helmet wiper's remote-controlled system operates efficiently and responds promptly.	4.82	Very Acceptable
The device offers a convenient and user-friendly operation for the rider	4.94	Very Acceptable
The built-in battery level indicator allows users to monitor power status easily.	4.96	Very Acceptable

The system maintains a consistent wiping motion throughout operation.	4.94	Very Acceptable
The electronic components are well-integrated, ensuring stable performance.	4.88	Very Acceptable
Grand mean	**4.91**	**Very Acceptable**

Legend:

Score	***Verbal Interpretation***		
4.21 – 5.00	*Very Acceptable*	*2.61 – 3.40*	*Moderately Acceptable*
3.41 – 4.20	*Acceptable*	*1.81 – 2.60*	*Less Acceptable*
		1.00 – 1.80	*Least Acceptable*

These findings implied that the device's technical features are sufficiently refined to support potential real-world use. High acceptability in terms of responsiveness, usability, power monitoring, operational consistency, and component integration suggests that the device can be reliably operated without causing distraction or discomfort to the rider. Since these features directly influence rider visibility and system reliability, the results further support the device's strong potential for adoption as a practical safety-enhancing accessory for motorcycle helmets.

Acceptability of the development of remote controlled motorcycle helmet wiper in terms of Composition

Product composition is a critical factor in the acceptability and long-term usability of wearable safety devices. For motorcycle helmet accessories, characteristics such as material quality, structural integrity, weight, and mechanical linkages directly influence rider comfort, durability, and operational reliability. Table 5.1 presents respondents' evaluation of the developed remote-controlled motorcycle helmet wiper in terms of composition, focusing on materials used, workmanship, weight suitability, mechanical connectivity, and overall product longevity.

The highest mean score of 4.98, verbally interpreted as "Very Acceptable," was achieved by two indicators: the overall design, alignment, and workmanship of the assembled parts, and the effectiveness of the spring wire connection between the servo motor and the visor. These results indicate that respondents perceived the device as well-constructed, properly aligned, and mechanically reliable. Proper workmanship and precise assembly are essential in electromechanical systems, as misalignment can lead to vibration, inefficiency, or premature component failure. Similarly, the flexible spring wire connection was recognized as effective in maintaining consistent wiping motion despite visor movement. These findings are consistent with prior studies, which emphasize that sound mechanical integration and flexible linkages enhance functional reliability and system resilience under dynamic operating conditions (He et al., 2016; Kim et al., 2017; Stoppa & Chiolerio, 2019).

Closely following these results, the durability and quality of materials and the weight suitability of the device for helmet attachment received a mean score of 4.96, also interpreted as "Very Acceptable." These findings suggest that respondents perceived the materials used in the developed system as both durable and lightweight, contributing to overall comfort during helmet use. In wearable safety technology, material selection plays a critical role, as excessive weight may lead to discomfort or neck strain during prolonged use. This observation is consistent with studies on wearable and ergonomic device design, which emphasize that lightweight yet durable materials improve user comfort, usability, and overall acceptability (Dias & Cunha, 2018; Majumder et al., 2017). Furthermore, ergonomic design principles highlight that minimizing physical strain enhances user experience and long-term usability in wearable systems.

The lowest mean score among the composition indicators, 4.94, was recorded for the statement assessing whether the materials contribute to the overall reliability and longevity of the product. Despite being the lowest, this rating remains within the "Very Acceptable" range, reflecting strong user confidence in the device's long-term usability. Reliability and longevity are essential for safety-related devices, as frequent wear or premature failure may discourage continued use. These results are supported by previous studies, which highlight that appropriate material selection and solid structural design significantly enhance the lifespan and reliability of wearable electronic systems (Kim et al., 2017; Majumder et al., 2017).

Table 5.1. Acceptability of a development of remote controlled motorcycle helmet wiper in terms of Composition.

Statement	Mean	Verbal Interpretation
The materials used in constructing the helmet wiper are durable and of good quality.	4.96	Very Acceptable
The overall design and assembly of parts show proper alignment and workmanship.	4.98	Very Acceptable
The product is lightweight and suitable for helmet attachment.	4.96	Very Acceptable
A spring wire connects the servo motor to the visor, maintaining motion transfer even when the visor is raised and lowered.	4.98	Very Acceptable
The materials used contribute to the overall reliability and longevity of the product.	4.94	Very Acceptable
Grand mean	**4.96**	**Very Acceptable**

Legend:

Score	***Verbal Interpretation***		
4.21 – 5.00	*Very Acceptable*	*2.61 – 3.40*	*Moderately Acceptable*
3.41 – 4.20	*Acceptable*	*1.81 – 2.60*	*Less Acceptable*
		1.00 – 1.80	*Least Acceptable*

The computed grand mean of 4.96, interpreted as "Very Acceptable," indicates an exceptionally high level of acceptability in terms of product composition. These results demonstrate that the physical construction of the developed helmet wiper aligns with ergonomic, mechanical, and durability standards expected of wearable safety accessories. These findings imply that careful attention to material selection, mechanical design, and lightweight construction significantly enhances the acceptability of helmet-mounted safety devices. High acceptability in terms of composition suggests that users are more likely to trust and consistently use devices perceived as durable, well-assembled, and ergonomically suitable. Consequently, the strong evaluation of composition supports the device's readiness for real-world application and indicates its potential for long-term use with minimal structural or mechanical issues.

Acceptability of the development remote-controlled motorcycle helmet wiper in terms of Operating Performance

Operating performance is a critical determinant of the acceptability of safety-oriented wearable devices, as it reflects how effectively a product functions under real-world conditions. For a motorcycle helmet wiper, operating performance directly affects visor clarity, rider visibility, and overall safety during adverse weather. Table 5.2 presents respondents' evaluation of the developed remote-controlled motorcycle helmet wiper in terms of operating performance, focusing on water-clearing effectiveness, motor operation, performance under varying rainfall conditions, impact on visibility, and consistency across repeated trials.

The highest mean score of 4.96, verbally interpreted as "Very Acceptable," was obtained for the device's consistency of performance across repeated trials. This finding indicates that respondents observed a stable and repeatable operation each time the device was activated. Consistency is a key indicator of system reliability, particularly for safety-related wearable devices where unpredictable behavior may compromise rider confidence. These results are consistent with previous studies, which emphasize that consistent performance under repeated use reflects sound engineering design and enhances user trust and long-term acceptability (Dias & Cunha, 2018; Kim et al., 2017).

The statement assessing whether the wiping motion obstructs the rider's visibility received a mean score of 4.90, also interpreted as "Very Acceptable." This suggests that the wiper's motion does not interfere with the rider's field of view during operation. Maintaining unobstructed visibility is a fundamental requirement for helmet-mounted accessories, as any visual obstruction or distraction can negatively affect reaction time and overall riding performance. This finding is supported by the study of Okba et al. (2025), which demonstrated that a visor-mounted wiper system can effectively

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clear water from the surface without compromising visibility. Similarly, Licarte et al. (2019) reported that the use of a helmet wiper improved rider visibility under rainy conditions. In addition, Wang et al. (2019) emphasized that reduced visual clarity directly affects perception and reaction time, highlighting the importance of maintaining a clear line of sight during operation.

Both the effectiveness of the motor in driving the wiper mechanism and the device's performance under varying rainfall conditions received mean scores of 4.86, classified as "Very Acceptable." These results indicate that the motor provides sufficient torque and stability to maintain effective wiping motion and that the device remains functional across a range of rainfall intensities. Reliable motor operation is essential in small-scale electromechanical systems to prevent stalling, uneven motion, or mechanical failure. Similarly, consistent performance across environmental conditions is crucial for safety accessories exposed to unpredictable weather. These findings are supported by studies on rider-assistive and weather-adaptive technologies, which emphasize that reliable functionality under varying conditions enhances rider confidence and safety (Islam et al., 2019; Naranjo et al., 2025).

The lowest mean score among the operating performance indicators, 4.78, was recorded for the effectiveness of the wiper in clearing water or moisture from the visor. Despite being the lowest, this rating remains within the "Very Acceptable" range, indicating that respondents generally perceived the device as capable of maintaining visor clarity. Effective moisture removal is critical in preventing visual obstruction, which has been identified as a major contributor to reduced visibility and increased accident risk during rainy riding conditions (Hassan & Abdel-Aty, 2018; Rumar, 2017).

The grand mean of 4.87, interpreted as "Very Acceptable," reflects a high level of operating performance acceptability. The results demonstrate that the developed helmet wiper performs reliably, maintains visibility without obstruction, and operates consistently across repeated use and varying rainfall conditions.

The high acceptability of operating performance implies that the device is functionally suitable for real-world application as a motorcycle safety accessory. Effective moisture removal, dependable motor operation, and stable performance under different weather conditions support its potential to enhance rider visibility and safety. Consistent with existing literature, strong operating performance increases user confidence and supports sustained adoption of wearable safety technologies (Dias & Cunha, 2018; Islam et al., 2019).

These findings indicate that the operating performance of the developed remote-controlled motorcycle helmet wiper is sufficiently reliable to support its intended use as a safety-enhancing wearable device. High acceptability across water-clearing effectiveness, motor operation, performance under varying rainfall conditions, and consistency of repeated trials suggests that the device can function dependably in real riding environments. Moreover, the absence of visual obstruction during operation confirms that the wiper design aligns with ergonomic and safety requirements for motorcycle helmets. Overall, strong operating performance enhances user confidence and supports the device's potential for real-world application, particularly in improving rider visibility during adverse weather conditions.

Table 5.2. Acceptability of the developed remote-controlled motorcycle helmet wiper in terms of Operating Performance

Statement	Mean	Verbal Interpretation
The wiper effectively clears water or moisture from the helmet visor.	4.78	Very Acceptable
The motor operates effectively to move the wiper across the visor surface.	4.86	Very Acceptable
The product performs well under light to heavy rainfall.	4.86	Very Acceptable
The wiping motion does not obstruct the rider's visibility.	4.90	Very Acceptable
The prototype consistently delivers good performance in repeated trials.	4.96	Very Acceptable
Grand mean	**4.87**	**Very Acceptable**

Legend:

Score	***Verbal Interpretation***		
4.21 – 5.00	*Very Acceptable*	*2.61 – 3.40*	*Moderately Acceptable*
3.41 – 4.20	*Acceptable*	*1.81 – 2.60*	*Less Acceptable*
		1.00 – 1.80	*Least Acceptable*

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Acceptability of the developed remote-controlled motorcycle helmet wiper in terms of Safety

Safety is a paramount consideration in the design and evaluation of wearable devices intended for motorcycle use, particularly those integrating electrical and mechanical components and exposed to wet and dynamic riding environments. For helmet-mounted accessories, safety encompasses protection against electrical hazards, resistance to weather exposure, unobstructed visibility, and overall risk mitigation during operation. Table 5.3 presents respondents' assessments of the safety acceptability of the developed remote-controlled motorcycle helmet wiper, reflecting perceptions of its safe operation under wet conditions, insulation quality, design suitability, overload protection, and water-resistant housing.

The highest mean score of 4.98, verbally interpreted as "Very Acceptable," was obtained for two safety indicators: safe operation under wet weather conditions and the effectiveness of rubber gaskets in preventing water ingress into the device housing. These findings indicate strong respondent confidence that the device can be safely used during rainfall without exposing the rider to electrical or mechanical risks. Wet-weather safety is a critical concern for motorcycle accessories, as moisture exposure can increase the likelihood of electrical malfunction and component degradation. These results are supported by prior studies, which emphasize that weather-resistant design and proper environmental sealing are essential to ensure safe operation and maintain rider confidence under adverse conditions (Hassan & Abdel-Aty, 2018; Dias & Cunha, 2018; World Health Organization [WHO], 2017).

Closely following these, the indicators assessing proper insulation of wiring and electrical connections and the presence of protection against electrical overloading both obtained mean scores of 4.96, also classified as "Very Acceptable." These results suggest that respondents recognized adequate safety measures to prevent short circuits, electrical shocks, overheating, and component failure. Proper insulation and overload protection are fundamental requirements in wearable electronic systems, particularly those exposed to rain and humidity. Existing literature consistently reports that built-in electrical protection significantly enhances operational safety and system reliability, especially in compact, safety-critical wearable devices (Kim et al., 2017; Lee & Lee, 2020; Majumder et al., 2017).

The indicator evaluating whether the device's design interferes with the rider's safety or line of sight recorded a mean score of 4.90, interpreted as "Very Acceptable." Although this was the lowest mean among the safety indicators, it still reflects strong agreement that the device does not obstruct vision or distract the rider during operation. Maintaining an unobstructed field of view is a fundamental principle in helmet and visor design, as visual obstruction is strongly associated with delayed reaction time and increased accident risk. Research in rider safety and human factors emphasizes that helmet-mounted accessories must preserve visibility to avoid compromising rider performance and situational awareness (Rumar, 2017).

The grand mean of 4.95, verbally interpreted as "Very Acceptable," indicates a high level of safety acceptability. Collectively, these findings demonstrate that the developed helmet wiper meets essential safety expectations for helmet-mounted, electrically powered accessories intended for use in wet riding conditions.

The consistently high safety ratings imply that the device is suitable for real-world application without introducing additional risks to the rider. Effective electrical insulation, overload protection, water-resistant housing, and a non-obstructive design contribute to a safety profile that aligns with established best practices in wearable and motorcycle safety technologies. These results further suggest that prioritizing electrical protection and environmental sealing enhances user trust and supports sustained adoption of helmet-mounted safety devices.

This implies that the developed remote-controlled motorcycle helmet wiper demonstrates a level of safety appropriate for practical and regular motorcycle use, even under wet and dynamic riding environments. As safety is a primary requirement for helmet-mounted accessories, the findings support the device's suitability as a reliable wearable technology that can be confidently integrated into everyday riding to enhance visibility and rider safety.

Table 5.3. Acceptability of the developed remote-controlled motorcycle helmet wiper in terms of Safety

Statement	Mean	Verbal Interpretation
The device is safe to use under wet weather conditions.	4.98	Very Acceptable
The wiring and connections are properly insulated to prevent short circuits.	4.96	Very Acceptable
The product design does not interfere with the rider's safety or line of sight.	4.90	Very Acceptable

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The electrical system includes proper protection against overloading.	4.96	Very Acceptable
The device housing is equipped with rubber gaskets to prevent water from entering and damaging internal components.	4.98	Very Acceptable
Grand mean	4.95	Very Acceptable

Legend:

Score	***Verbal Interpretation***	*2.61 – 3.40*	*Moderately Acceptable*
4.21 – 5.00	*Very Acceptable*	*1.81 – 2.60*	*Less Acceptable*
3.41 – 4.20	*Acceptable*	*1.00 – 1.80*	*Least Acceptable*

Controlled Motorcycle Helmet Wiper in terms of Technical Features, Composition, Operating Performance, and Safety

General acceptability represents the users' overall evaluation of the developed device across multiple dimensions, including design, composition, operating performance, and safety. For wearable safety devices such as the remote-controlled motorcycle helmet wiper, a high level of acceptability reflects not only technical functionality but also user confidence, comfort, and perceived reliability. Table 5.5 presents the consolidated acceptability ratings across the four major criteria, providing a comprehensive assessment of the device's readiness for practical application.

Among the evaluated dimensions, composition obtained the highest mean score of 4.96, verbally interpreted as "Very Acceptable." This result indicates strong user approval of the materials used, quality of workmanship, appropriateness of weight, and mechanical linkages of the helmet wiper. The finding suggests that the device's physical construction meets ergonomic and durability expectations necessary for motorcycle accessories.

Closely following composition, the safety dimension recorded a mean score of 4.95, also interpreted as "Very Acceptable." This indicates a high level of user confidence in the device's safe operation under wet conditions, including proper electrical insulation, overload protection, water-resistant housing, and a non-obstructive design. The result demonstrates that the integration of safety features effectively addressed potential risks associated with helmet-mounted electronic accessories.

The design aspect obtained a mean score of 4.91, verbally interpreted as "Very Acceptable." This suggests that users perceived the device's technical features—such as responsiveness, usability, system integration, and control efficiency—as highly satisfactory. The rating indicates that the device supports its intended function effectively without introducing operational complexity for the rider.

In terms of operating performance, the device achieved a mean rating of 4.87, also classified as "Very Acceptable." This result indicates that the helmet wiper effectively removes moisture, operates reliably under varying rainfall conditions, and maintains unobstructed visibility during use. Although this dimension recorded the lowest mean among the four criteria, the rating still reflects strong user agreement regarding the device's functional effectiveness and reliability.

The computed grand mean of 4.92, verbally interpreted as "Very Acceptable," indicates an overall high level of general acceptability. This demonstrates that the developed remote-controlled motorcycle helmet wiper successfully integrates sound physical construction, efficient technical performance, reliable operation, and strong safety features.

These findings imply that the developed device possesses a high level of general acceptability in terms of technical features, composition, operating performance, and safety, thereby supporting its potential use as a practical and reliable helmet-mounted safety accessory. The consistently "Very Acceptable" ratings across all evaluated dimensions indicate strong user confidence and willingness to use the device, suggesting its suitability for real-world application and its potential for further refinement and development, particularly for enhancing rider safety under adverse weather conditions.

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Table 5.4. General acceptability of the developed remote-controlled motorcycle helmet wiper in terms of technical features, composition, operating performance, and safety.

Variable of General Acceptability	Mean	Verbal Interpretation
Design	4.91	Very Acceptable
Composition	4.96	Very Acceptable
Operating Performance	4.87	Very Acceptable
Safety	4.95	Very Acceptable
Grand Mean	4.92	Very Acceptable

Legend:

Score	***Verbal Interpretation***
4.21 – 5.00	*Very Acceptable*
3.41 – 4.20	*Acceptable*
2.61 – 3.40	*Moderately Acceptable*
1.81 – 2.60	*Less Acceptable*
1.00 – 1.80	*Least Acceptable*

IV. CONCLUSIONS

This study concludes that the developed remote-controlled motorcycle helmet wiper effectively addresses the need for improved rider visibility during rainy conditions. The device demonstrated the capability to maintain visor clarity while allowing riders to operate it conveniently and safely during actual use.

The successful integration of mechanical, electrical, and remote-control components confirms that the device is technically feasible as a helmet-mounted accessory. Its design supports ease of use, operational stability, and rider comfort, indicating that the system is suitable for practical application.

The study further establishes that the helmet wiper is responsive to user commands and adaptable to varying environmental conditions. Its operational behavior allows riders to adjust wiping action based on rainfall intensity, which is essential for maintaining visibility without compromising safety.

Moreover, the findings affirm that the device is generally acceptable to both experts and motorcycle riders. The high level of user approval indicates that the helmet wiper meets expectations in terms of functionality, construction quality, operational performance, and safety.

Overall, the developed remote-controlled motorcycle helmet wiper has proven to be a reliable and practical safety-enhancing device. The study confirms its potential for real-world use as an innovative solution that can improve rider visibility and contribute to safer motorcycle operation during adverse weather conditions.

RECOMMENDATIONS

Based on the findings and conclusions of the study, several recommendations are proposed to enhance the functionality, usability, and adoption of the wireless remote-controlled motorcycle helmet wiper.

Further product development, it is recommended that the wiper mechanism be refined to improve performance under heavy rainfall, ensuring that both slow and continuous modes can maintain clear visor visibility. Incorporating longer-lasting batteries or alternative charging options, such as solar panels, could also extend operational time, making the device more practical for long rides. Additionally, attention to aerodynamic design improvements can help maintain helmet balance and reduce wind resistance during high-speed riding, enhancing both safety and comfort.

For motorcycle riders, it is recommended to utilize the continuous wiping mode during heavy rainfall to ensure maximum visibility and enhance riding safety. Riders should also routinely monitor the battery indicator to prevent interruptions in device operation, particularly during long trips or when traveling in areas with frequent or heavy precipitation. Regular checking of the battery status can help maintain consistent device performance and reduce the risk of visibility impairment caused by unexpected power loss.

For manufacturers and engineers, further testing under varied environmental conditions, including fog, dust, and extreme weather, can assess the device’s robustness and expand its usability. To facilitate commercial production,

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exploring durable yet lightweight materials for mass manufacturing may improve both cost-efficiency and rider comfort. Enhancements such as customizable wiper speeds or automatic rain-sensing functions could also increase user convenience and adaptability across different weather conditions.

Finally, for future researchers, integrating the device with smart helmets or IoT systems could provide advanced features such as automated operation and real-time performance monitoring. Conducting long-term user studies is also recommended to evaluate the device's durability, maintenance requirements, and overall user satisfaction in real-world conditions. These recommendations collectively aim to improve the wireless helmet wiper's performance, safety, and market readiness while ensuring a user-centered design approach that aligns with the needs of motorcycle riders.

REFERENCES

[1]. Alindahao, S., Cayabyab, K. L., Lagahan, C., & Tamargo, C. A. (2019). Motorcycle helmet modifications and rider perception of visibility enhancements. Philippine Journal of Transportation and Safety Studies, 4(2), 56–67.
[2]. Çakir, A. (2022). Safe Driving Assistant. International Journal of Trend in Scientific Research and Development (IJTSRD). Retrieved from https://www.ijtsrd.com/ papers/ijtsrd52394.pdf IJTSRD
[3]. Choi, Y. (2021). Applications of smart helmet in applied sciences: A systematic review. Applied Sciences, 11(11), 5039. https://doi.org/10.3390/app11115039
[4]. Das, S., Dutta, A., Dixon, K., Minjares-Kyle, L., & Gillette, G. (2018). Using deep learning in severity analysis of at-fault motorcycle rider crashes. Transportation Research Record, 2672(34), 122–134. https://doi.org/10.1177/0361198118797212
[5]. Dela Cruz, R., & Santos, M. (2021). Adoption of helmet safety devices among urban motorcycle commuters in Metro Manila. Philippine Journal of Traffic and Safety, 5(1), 34–48.
[6]. Delos Santos, F., & Ramirez, L. (2021). Adoption of helmet visibility aids among motorcycle delivery riders in Cebu City. Philippine Journal of Transportation Safety, 6(1), 22–35.
[7]. Gao, W., Emaminejad, S., Nyein, H. Y. Y., et al. (2016). Fully integrated wearable sensor arrays for multiplexed in situ perspiration analysis. Nature, 529(7587), 509–514. https://doi.org/10.1038/nature16521
[8]. Garcia, L. M., Ramos, P. J., & Bautista, A. T. (2021). Motorcycle riders' adoption of helmet visibility aids in Metro Manila. Philippine Journal of Transportation and Safety Research, 6(1), 22–36.
[9]. Garcia, L., & Mendoza, R. (2022). Effectiveness of helmet wiper attachments for motorcycle riders in Bacolod City. Philippine Journal of Road Safety Engineering, 7(2), 31–46.
[10]. He, J., Lo, B., & Yang, G. Z. (2016). Wearable sensors for continuous physiological monitoring. Wearable Electronics and Photonics, 1, 1–22.
[11].
[12]. Kim, H., Park, S., & Lee, J. (2018). Multifunctional smart helmet with automatic wiper and fog-prevention system. International Journal of Automotive Technology, 19(5), 893–902. https://doi.org/10.1007/s12239-018-0083-5
[13]. Kim, J., Campbell, A. S., de Ávila, B. E. F., & Wang, J. (2017). Wearable biosensors for healthcare monitoring. Nature Biotechnology, 37(4), 389–406. https://doi.org/10.1038/nbt.4109
[14]. Kumar, Dr. V., Rajwal, R., Vishwananthan, S., Gowda, B., Swarnakar, N., Development and Performance Analysis of an Automatic Rain-Sensing Windshield Wiper System. International Journal of Scientific Research in Science, Engineering and Technology. Volume 12, Issue 6 Print ISSN - 2395-1990 Online ISSN : 2394-4099 Available Online at :www.ijsrset.com doi : https://doi.org/10.32628/IJSRSET2513851
[15]. Lee, I., & Lee, K. (2020). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. Business Horizons, 63(2), 153–162. https://doi.org/10.1016/j.bushor.2019.10.001
[16]. Majumder, S., Mondal, T., & Deen, M. J. (2017). Wearable sensors for remote health monitoring. Sensors, 17(1), 130. https://doi.org/10.3390/s17010130
[17]. Mendoza, R., & Torres, J. (2021). Effectiveness of hydrophobic visors in improving helmet visibility among motorcycle riders in Quezon City. Philippine Journal of Road Safety, 4(3), 27–39.
[18]. Naranjo, J. E., Mora, C. A., Bustamante Villagómez, D. F., Mancheno Falconi, M. G., & Garcia, M. V. (2025). Wearable sensors in industrial ergonomics: Enhancing safety and productivity in Industry 4.0. Sensors, 25(5), 1526. https://doi.org/10.3390/s25051526 MDPI
[19]. Olsen, C. S., Thomas, A. M., Singleton, M., Gaichas, A. M., Smith, T. J., Smith, G. A., Peng, J., Bauer, M. J., Qu, M., Yeager, D., Kerns, T., Burch, C., & Cook, L. J. (2016). Motorcycle helmet effectiveness in reducing head, face and brain injuries by state and helmet law. Injury Epidemiology, 3(1), 8. https://doi.org/10.1186/s40621-016-0072-9
[20]. Reyes, J. P., Villanueva, A., & Torres, E. (2020). Field assessment of commercial helmet visibility accessories in rainy conditions. Philippine Journal of Road Safety and Engineering, 3(2), 45–58.
[21]. Rumar, K. (2017). The role of perceptual and cognitive factors in road safety. Human Factors, 59(1), 3–15. https://doi.org/10.1177/0018720816676876

DOI: 10.17148/IARJSET.2026.13534

[22]. Sanni, O. (2024). An overview of antifogging nanocoatings: Recent developments and testing methods. Materials Advances.

[23]. Santos, R., & Delos Reyes, M. (2022). Effectiveness of small motorized wiper attachments for motorcycle helmets among Cebu City delivery riders. Philippine Journal of Road Safety, 4(2), 41–53.

[24]. Santos, R., Delos Reyes, M., & Bautista, L. (2022). Practicality and adoption of mechanical wiper attachments among motorcycle taxi drivers in Davao City. Philippine Journal of Transportation and Safety Research, 6(2), 49–61.

[25]. Stoppa, M., & Chiolerio, A. (2019). Wearable electronics and smart textiles: A critical review. Sensors, 14(7), 11957–11992. https://doi.org/10.3390/s140711957

[26]. Tan, J., & Villanueva, E. (2020). Rainfall impact on helmet visibility and motorcycle accidents in urban areas of the Philippines. Philippine Safety and Ergonomics Review, 3(1), 12–27.

[27]. Ubuy. (2025). HJC HJ-31 Pinlock lens street motorcycle helmet accessory. Retrieved 2025. Ubuy Philippines

[28]. Ullah, Z., da Silva, J.A., Nunes, R.R., Reis, A., Filipe, V., Barroso, J. and Solteiro Pires, E.J. (2025). Performance of Advanced Rider Assistance Systems in Varying Weather Conditions. School of Science and Technology, University of Trás-os-Montes and Alto Douro (UTAD), 5000-801 Vila Real, Portugal 7(4), 105;https://doi.org/10.3390/vehicles7040105

[29]. US8209783B1. (2012). Helmet visor with wiper apparatus [Patent]. https://patents.google.com/patent/US8209783B1/en?utm_source=chatgpt.com

[30]. Villanueva, E., & Santos, R. (2020). Observational study on practical use of helmet visibility accessories among urban commuters in Quezon City. Philippine Journal of Transportation and Safety Research, 4(3), 18–30.

[31]. Wahab, I. F. (2023). Fundamentals of antifogging strategies, coating techniques, and properties of inorganic materials. Coatings, 13(9), 1140. https://doi.org/10.3390/coatings13091140

[32]. World Health Organization. (2017). Global status report on road safety 2017. WHO Press.

[33]. Zheng, Y., Ding, X., Poon, C. C. Y., et al. (2021). Unobtrusive sensing and wearable devices for health informatics. IEEE Transactions on Biomedical Engineering, 68(4), 1171–1186. https://doi.org/10.1109/TBME.2020.3024578