SOUTHEAST ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

SMART RAD (RIDER ALCOHOL DETECTOR): A MOTORCYCLE SAFETY SYSTEM FOR LA TRINIDAD, BENGUET

Jhaynher M. Felix[1], Bernie O. Colempep[2], Kyzer B. Lumbican[3], Libby Ihlyn B. Teofilo[4], Kyle Keith Pio[5], Jehanne W. Tomas[6], Paul Jayzer P. Comila[7]
King's College of the Philippines
Pico Rd. La Trinidad, Benguet, 2601

Article Info:
Received: ***10 June 2024;*** *Revised:* ***05 Nov 2024;*** *Accepted:* ***01 Dec 2024;*** *Available Online:* ***15 Jan 2024***

Abstract *- Smart RAD (Rider Alcohol Detector) System is a Proof-of-Concept (PoC) aimed at addressing drunk driving among motorcyclists. The system integrates an alcohol sensor into a helmet, which wirelessly communicates with the motorcycle's ignition system to prevent the engine from starting when alcohol is detected. A force-sensing resistor (FSR) ensures helmet usage, enhancing safety. Additionally, a mobile application provides real-time system monitoring. The system was developed using the Rapid Application Development (RAD) methodology, emphasizing user-centered design, iterative construction, and practical deployment. Architectural design was crucial in seamlessly integrating hardware and software components. Usability testing, guided by ISO 9241-11:2018 standards, revealed high user satisfaction, with respondents confident in the system's potential to prevent drunk riding and enhance road safety. Smart RAD helps promote motorcycle safety, particularly through its innovative integration of alcohol detection and helmet compliance mechanisms.*

Keywords *– Alcohol Detection System, Drunk Driving Prevention, Helmet Compliance, Motorcycle Safety, Road Safety Technology, Wireless Ignition Control*

INTRODUCTION

There are more than 770 million motorcycles in use worldwide. As a result, there are more than 1.3 million people die in road traffic crashes worldwide annually. Road traffic crashes are the 8th leading cause of death for people of all ages and the leading cause of death for children and young adults. More than half of all road traffic deaths are among vulnerable road users, which include pedestrians, cyclists, and motorcycle riders (World Health Organization, 2023).

Furthermore, driving under the influence ranks as the second global cause of road-related accidents (Zhao, et al., 2019). Each year, alcohol causes about 10,000 deaths in Europe (Keall, et al., 2020). Roughly one-third of all traffic fatalities in the United States occur as a result of collisions caused by drunk drivers (POEU, 2023). Traffic accidents claimed the lives of 11,246 people in the Philippines, with motorcycle riders accounting for almost 53% of those fatalities. A variety of variables cause traffic accidents, with human error being the most frequent cause (IEE Conference Publication, 2020).

Drinking while driving significantly reduces a rider's reaction time and ability to make quick decisions, putting other road users and the driver in danger (NSW, nd). Because of this, numerous nations have invested considerable time in initiatives to prevent drunk driving, including public awareness campaigns, educational initiatives, and strictly enforced legislation. There are already established laws prohibiting driving after intoxication, and offenders face severe

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

penalties (Hyder, Vecino, 2020). However, it is too hard to completely stop drinking and then get behind the wheel.

Under Republic Act No. 10586, also known as the "Anti-Drunk and Drugged Driving Act of 2013," the legal Blood Alcohol Concentration (BAC) limit for non-professional drivers, including motorcycle riders, is set at 0.05%. This means that if a motorcyclist's BAC exceeds 0.05%, they are considered under the influence of alcohol, which is prohibited under the law. For professional drivers and operators of public utility vehicles, a stricter limit of 0.01% is enforced to ensure the safety of passengers and the public.

Moreover, the Philippine law mandates the use of helmets in the Republic Act No. 10054, also known as the Motorcycle Helmet Act of 2009. This law requires all motorcycle riders, both drivers and passengers, to wear standard protective helmets while driving on public roads.

In La Trinidad alone, Driving Under the Influence (DUI) is the main factor in early morning or pre-dawn vehicular accidents. Drunk motorcycle riders cause between 60% and 70% of vehicle-related accidents, according to the investigator under La Trinidad Municipal Police Station (LTMPS) – Traffic Section. One of the fire offices from La Trinidad Bureau of Fire Protection (LTBFP) also added that they regularly respond to vehicular accidents and that when they get on the scene, they always witness that the driver is intoxicated.

To resolve this critical issue, the proponents intended to develop Smart RAD (Rider Alcohol Detector): A Motorcycle Safety Application for La Trinidad Benguet. This system works by sending signals wirelessly to the motorcycle's ignition system. The helmet-mounted alcohol sensor will act as an interlock system that prevents starting the motorcycle whenever the device detects the presence of alcohol in a person's breath, thereby preventing drunk drivers from accessing motorcycles. This preventive strategy aims to reduce the number of motorcycle accidents involving drunk motorcyclists and ensure the safety of all road users.

By integrating a wide range of components, the system seeks to guarantee the reliable detection of alcohol, validation of helmet use, deactivation of the ignition system, and real-time mobile notification features.

The proposed solution, Smart RAD, complies with the United Nations Sustainable Development Goal (SDG) 3.6, aiming to reduce annual road traffic incidents by half by 2030 thereby, aims to minimize drunk driving incidents by motorcyclists, thus enhancing road safety (WHO, 2023).

OBJECTIVES OF THE STUDY

The Smart RAD: A Motorcycle Safety Application for La Trinidad Benguet aims: 1) To gather the requirements in developing the system; 2) To design the hardware and mobile application of the system; 3) To develop the hardware and mobile application of the system; and 4) To test and deploy the Smart RAD system.

METHODOLOGY

The project utilized the Rapid Application Development (RAD) methodology, which prioritizes rapid application development through frequent iterations and continuous feedback. As the software market becomes more competitive and the demand for new applications increases, the IT industry is under pressure to deliver working products faster, thereby making RAD a requirement (Chen, 2020). The methodology consists of four distinct phases:

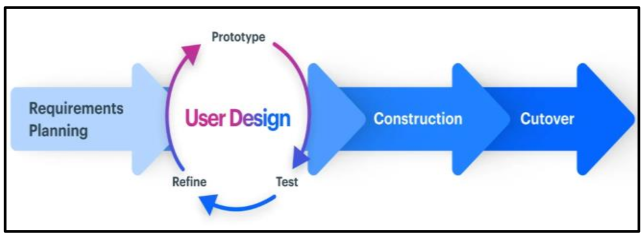

Fig. 1. RAD Methodology Phases

Phase 1: Requirements Gathering and Analysis

During this initial phase, the proponents gathered and established the system's requirements.

The proponents conducted research to identify the non-functional requirements, which are the tools and technologies, such as sensors and modules, for the system development.

To further refine the project criteria, the proponents conducted surveys to gather valuable data directly from the target demographic. The research population involved the motorcyclists in La Trinidad, selected as they represent the primary users of the system. A sample size of 34 motorcyclists has been chosen, which was considered sufficient for a representative understanding of user expectations and preferences. A purposive sampling method was employed to specifically target motorcyclists with varying years of experience and riding habits, ensuring that responses reflect a range of perspectives within the intended user group.

To complement the survey data, the proponents conducted interviews with the relevant authorities and experts in road safety, law enforcement, and technology. These interviews aim to gather qualitative data, including suggestions and opinions about the system's potential impact and feasibility.

Ethical Considerations

Ethical considerations were given top priority to ensure the safety, privacy, and well-being of all participants. The risks involved were minimal, mainly consisting of slight discomfort during the survey. The primary benefit for participants is contributing to the development of a technology-driven solution to enhance motorcycle safety. Participants were fully informed of the project's purpose, benefits, and any potential risks through a detailed consent form. They were given the freedom to withdraw from the study at any time without facing any consequences. To protect privacy, all data collected from the participants were anonymized, securely stored, and used solely for the purpose of the project.

Phase 2: System Design and Prototyping

During this phase, the proponents clearly outlined the design specifications and user interfaces of the system which includes:

Hardware Design (System Architecture Design)

The proponents designed the system architecture for the hardware components of the Smart RAD project. This includes simulation, selecting and integrating the necessary sensors, such as the alcohol sensor and force sensing resistor (FSR), along with the microcontroller (Arduino) and the Bluetooth module for wireless communication using software applications such as circuit sketch designers, etc. The design also covers the creation of the circuit diagrams, ensuring proper power distribution, and establishing the connection between the helmet's safety features and the motorcycle's ignition system.

Mobile Application Design (Software Architecture Design)

Alongside the hardware design, the proponents created the mobile application design for the system, focusing on the software architecture that ensures seamless communication between the mobile app and the hardware via Bluetooth. This stage includes designing the user interface (UI) and user experience (UX) on Figma to ensure ease of use and real-time monitoring of the system's status. The application will integrate key functionalities like alcohol detection, and alert notifications.

Phase 3: System Development and Integration

This phase involves the construction and assembly of the system based on the pre-designed and specified components which are:

System Assembly and Programming

The hardware was assembled on a breadboard to allow for modifications during testing. Firmware was uploaded to the Arduino microcontrollers, focusing on Bluetooth communication, alcohol detection thresholds, and helmet compliance data processing.

For the software, built-in packages of the Flutter development kit were utilized to create the prototype to a functioning mobile application.

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

Performance Testing

In this testing stage, the proponents created and executed test cases to test the system under different conditions and scenarios. This includes testing the system's response to helmet usage compliance and different alcohol levels being detected.

Testing involved both controlled alcohol consumption by participants and the inclusion of individuals experiencing a real hangover. All procedures were conducted responsibly, with participants monitored closely to ensure their safety and well-being throughout the process. Strict protocols were followed to minimize risks and uphold ethical standards during testing. The hardware and the software components of the system were integrated together after the performance testing.

Phase 4: Testing and Deployment

At this point, the proponents executed conclusive testing, deploy enhancements, and prepare for the PoC presentation, focusing on usability testing.

Usability testing is used to evaluate the effectiveness, efficiency, and user satisfaction of the system, in line with the guidelines of the International Organization for Standardization (ISO 9241-11:2018).

A total of 102 respondents were surveyed, all of whom were motorcyclists from La Trinidad, Benguet. The testing was administered through a Google Forms survey, which included a video demonstration of the SMART RAD system.

RESULTS AND DISCUSSION

Phase 1: Requirements Gathering and Analysis

The proponents selected hardware components such as alcohol sensors, FSRs, and Bluetooth modules for wireless communication. Arduino microcontrollers were selected for their compatibility and ease of programming, ensuring that the PoC was both functional and cost-effective.

Surveys

The survey results include the following:

- <u>Demographics</u>: The majority of respondents were aged 18-24, followed by those aged 25-34. Most respondents were male and had been riding motorcycles for 1-3 years or 4-6 years. In terms of riding habits, daily riding was the most common, with a significant number riding weekly.
- <u>Helmet Usage and Alcohol Influence</u>: While 76.5% of respondents always wear helmets, there are still instances of non-compliance. Alarmingly, 58.52% admitted to riding under the influence of alcohol. Additionally, 55.88% of respondents witnessed alcohol-related motorcycle accidents, and 23.53% were directly involved in such incidents.
- <u>Technology Awareness and Attitude</u>: A large majority (67.6%) were unaware of existing technology to prevent drunk riding. However, 88.2% expressed agreement that they would feel safer knowing such a system was in place to prevent drunk riding.

Ethical considerations were observed during the survey, ensuring voluntary participation and data confidentiality.

Category	LTBFP	LTMPS Traffic Section
Role/position	Fire Officer II, Spare Driver	Traffic Field Supervisor
Experience in field	8 years (2 years responder)	17 years as Traffic Investigator
Challenges in enforcement	Limited manpower and resources	Public resistance; coordination issues
Current preventive measures	Educational campaigns showing accident visuals	Curfew hours for alcohol drinking and checkpoints

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

Awareness of technology	Familiar with breath analyzers	Familiar with breath analyzers, limited use locally
Suggestions for Smart RAD	Early detection with simple alarms	Detect alcohol even if helmet isn't worn
Support for Smart RAD	Open to supporting; emphasizes extensive testing	Strongly supports; preventive solution

Table 1. Qualitative Data Interview from LTFS and LTMPS - Traffic Section

Category	**LTBFP**	**LTMPS Traffic Section**
Frequency of motorcycle accidents	Between daily & weekly	Daily
Percentage of drunk driving cases	60-70%	50%
Effectiveness of current measures	Neutral - Effective	Neutral
Effectiveness of Smart RAD	Very Effective	Very Effective
Openness to new technology	Very Open	Very Open

Table 2. Quantitative Data Interview from LTFS and LTMPS - Traffic Section

Interviews

Tables 1 and 2 shows the interview results which involved the LTBFP and the LTMPS – Traffic Section. The feedback from these interviews provided valuable insights, which have informed the refinement of the system's requirements, functionality, and features.

Phase 2: System Design and Prototyping
Hardware Design (System Architecture Design)

In this phase, the Smart RAD flow was established. The process starts with the helmet usage detection. If the helmet is not worn as detected by the FSR, the motorcycle will not start. If the helmet is detected by the FSR as worn, then the alcohol sensor will detect the user's breath for alcohol content. If there is no alcohol detected, the motorcycle's ignition will be enabled and the motorcycle can be started. If the detected BAC percentage is less than 0.05%, the mobile application will show a notification indicating a safety reminder. The motorcycle's ignition will be enabled and the motorcycle can be started.

If the alcohol detected is more than 0.05% BAC, the motorcycle's ignition will be disabled, shutting down the motorcycle. The data from the alcohol sensor will be sent to the mobile application and the mobile application will display the user's BAC percentage. It will then send a text message via Short Message Service (SMS) to the registered emergency contacts in the mobile application, notifying the recipients with the current BAC percentage and that the user should not drive. The system's process is shown in Fig.2.

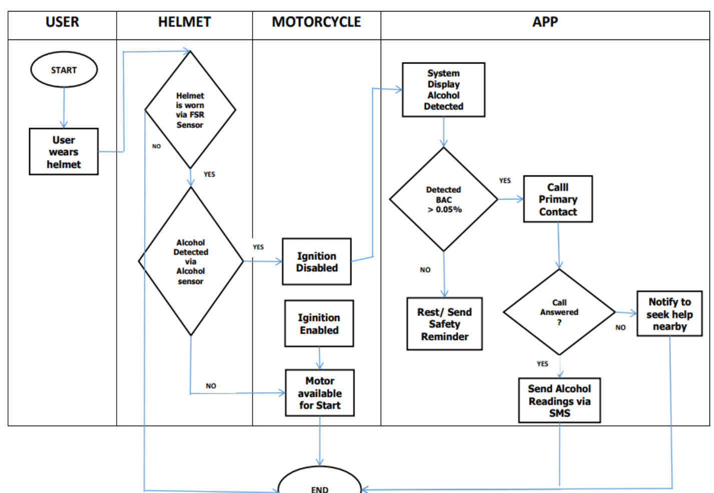

Fig. 2. Smart RAD System Flow

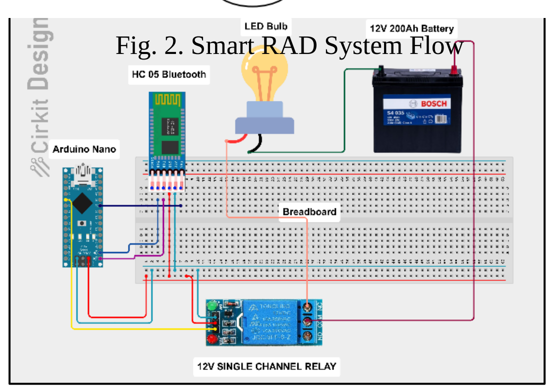

Fig. 3. Motorcycle System Diagram

SOUTHEAST ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

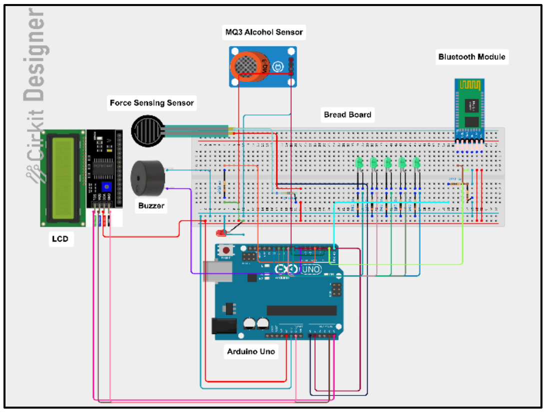

Fig. 4. Helmet System Diagram

Fig. 3 and Fig. 4 show the circuit diagrams for the motorcycle and helmet systems.

Mobile Application Design (Software Architecture Design)

The high-fidelity prototype of Smart RAD's mobile application was designed on Figma. The mobile application will show the current BAC percentage of the user, as detected by the alcohol sensor mounted on the helmet. The mobile application includes a contact page where the user enrolls trusted emergency contacts where the notification message will be sent. The message is automatically generated and sent to the emergency contacts.

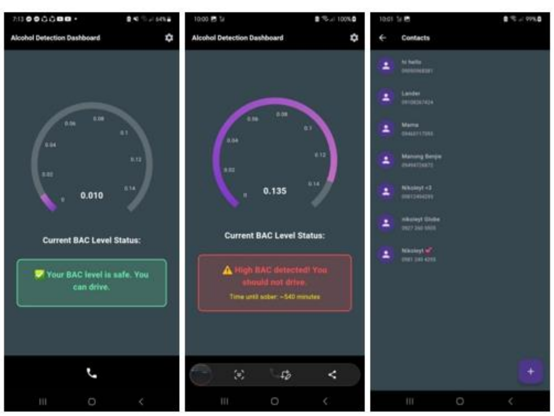

Fig. 5. Smart RAD Mobile Application Prototype

Phase 3: System Development and Integration

System Assembly and Programming

In this phase, the proponents were able to create the system attached to the helmet. This includes all the connection of the alcohol sensor, FSR, Bluetooth modules connected to the microcontroller with LED indications.

On the software side, connection was also integrated between the system and the mobile application, giving the full systems' functionality and capability to send and receive signals detected by the alcohol sensor.

Performance Testing

In this testing stage, the proponents created and executed test cases to test the system under different conditions and scenarios. This includes testing the system's response to helmet usage compliance and different alcohol levels being detected. Testing involved both controlled alcohol consumption by participants and the inclusion of individuals experiencing a real hangover, including proponents. All procedures were conducted responsibly, with participants monitored closely to ensure their safety and well-being throughout the process. Strict protocols were followed to minimize risks and uphold ethical standards during testing.

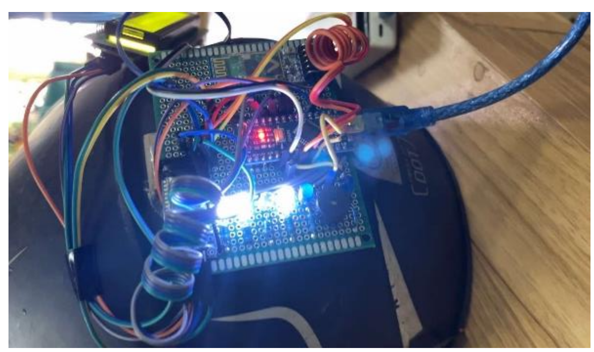

Fig. 6. Smart RAD attached to Helmet

Force Sensing Sensor

The law that mandates the use of helmets in the Philippines is Republic Act No. 10054, also known as the Motorcycle Helmet Act of 2009. This law requires all motorcycle riders, both drivers and passengers, to wear standard protective helmets while driving on public roads. The goal of this law is to reduce the risk of injury or death due to road accidents. Our system ensures that the helmet is worn before allowing the motorcycle to start.

By integrating a force sensor within the helmet, we are able to verify if the helmet is being worn properly by the rider. If the helmet is detected as being worn, the system then proceeds to check for alcohol levels using an alcohol sensor.

Sensor Value Range	LED 1	LED 2	LED 3	LED 4	LED 5	Helmet Status
sensor > 900	ON	ON	ON	ON	ON	Helmet Worn (Strong Pressure)
sensor > 800	ON	ON	ON	ON	OFF	Helmet Worn (Moderate Pressure)
sensor > 700	ON	ON	ON	OFF	OFF	Helmet Worn (Light Pressure)
sensor > 400	ON	ON	OFF	OFF	OFF	Helmet Worn (Very Light Pressure)
sensor <= 400	OFF	OFF	OFF	OFF	OFF	Helmet Not Worn

Table 3. Smart RAD LED Indicators Based on the Force Sensor Readings

MQ3 Alcohol Sensor

Under Republic Act No. 10586, also known as the "Anti-Drunk and Drugged Driving Act of 2013," the legal Blood Alcohol Concentration (BAC) limit for non-professional drivers, including motorcycle riders, is set at 0.05%. This means that if a motorcyclist's BAC exceeds 0.05%, they are considered under the influence of alcohol, which is prohibited under the law. For professional drivers and operators of public utility vehicles, a stricter limit of 0.01% is enforced to ensure the safety of passengers and the public.

BAC Percentage Range	Classification
0.00	No Alert
≤ 0.05	Low BAC
> 0.05	High BAC

Table 4. BAC Levels and Classifications Based on Percentage Ranges

Time Since Consumption (mins)	Type of Drink Consumed	Volume (ml)	BAC Detected (%)	BAC Level	Classification
15	Ginebra SM (40% ABV)	350	0.00	0	No Alert
30	Ginebra SM (40% ABV)	350	0.04	0	No Alert
60	Ginebra SM (40% ABV)	350	0.5	1	Low BAC
120	Ginebra SM (40% ABV)	350	0.3	0	No Alert

Table 5. Alcohol Absorption and Elimination Based on Time

Table 5 confirms that alcohol absorption occurs rapidly after consumption, typically peaking within 30-60 minutes.

However, the elimination process begins soon after the peak, with BAC levels gradually decreasing as the body metabolizes the alcohol. While the elimination process is slower compared to absorption, the BAC at 120 minutes is still significant, suggesting that the body requires more time to fully metabolize a large quantity of alcohol (350 ml of 40% ABV). This highlights the importance of considering both absorption and elimination rates when assessing alcohol impairment, as the effects of alcohol persist even as BAC begins to decline.

Consumption Level	Type of Drink Consumed	Volume (ml)	Time Since Consumption (mins)	BAC Detected (%)	Classification
Light	Ginebra SM (40% ABV)	350	30	0.01	No Alert

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

Moderate	Ginebra SM (40% ABV)	350	60	0.02	Low BAC
Heavy	Ginebra SM (40% ABV)	350	120	0.05	Medium BAC
Excessive	Ginebra SM (40% ABV)	350	300	0.09	Medium BAC

Table 6. Alcohol Absorption Based on Consumption Level and Volume

Table 6 indicates that with 350 ml of Ginebra San Miguel (40% ABV) consumed, the BAC rises gradually over time, with the highest increase seen at the 120-minute mark. The BAC reaches medium BAC levels at both 120 minutes and 300 minutes, suggesting that alcohol at this volume leads to prolonged intoxication. The rate of absorption is rapid, but the elimination process takes significantly longer, indicating that heavy or excessive drinking causes a prolonged period of intoxication. The light and moderate consumption (even at the same volume) result in relatively low BACs at 30-60 minutes, showing that time is a key factor in BAC levels, and the body requires more time to process alcohol when consumed in larger volumes.

This also applies to hangover cases—even if a person feels sober after a significant amount of time has passed since consumption, their BAC may still be elevated enough to cause impairment.

As such, regardless of how sober someone may feel, they cannot bypass a system designed to detect alcohol levels, ensuring that they are still unable to start a vehicle or engage in activities requiring full motor and cognitive abilities.

Phase 4: Testing and Deployment

At this point, the proponents executed conclusive testing, deploy enhancements, and prepare for the PoC presentation, including:

Usability Testing

Usability testing for the Smart RAD system was conducted to evaluate its effectiveness, efficiency, and user satisfaction, in line with the guidelines of the International Organization for Standardization (ISO 9241-11:2018). A total of 102 respondents were surveyed, all of whom were motorcyclists from La Trinidad, Benguet. The testing was administered through a Google Forms survey, which included a video demonstration of the Smart RAD system. The following findings summarize the key results of the usability testing, categorized into the three main dimensions of usability: effectiveness, efficiency, and satisfaction.

Effectiveness

Effectiveness measures the extent to which the system achieves its intended goals, specifically the prevention of drunk driving and ensuring helmet compliance among motorcyclists. The usability testing results indicate its core functions with a high degree of success:

Usability Dimension	**1**	**2**	**3**	**4**	**5**	**WM**	**Descriptive Interpretation**
Alcohol Detection Effectiveness	5	7	9	12	69	4.28	Agree
Helmet Compliance Reliability	7	9	11	8	60	4.14	Agree
Alcohol Detection Accuracy	6	10	9	9	64	4.20	Agree
Drunk Driving Prevention	8	6	10	9	69	4.26	Agree
Safety Perception	8	7	9	8	63	4.18	Agree

Table 7. Effectiveness Ratings of the SMART RAD System

Table 7 presents the respondents' ratings of the Smart RAD system's effectiveness, focusing on key features such as alcohol detection, helmet compliance, and its ability to prevent drunk driving. The highest average score, 4.28, was given to the system's alcohol detection effectiveness, showing that users generally agree that the system reliably detects alcohol and prevents ignition. However, features such as helmet compliance the system performs

SOUTHEAST ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

reliability and safety perception received slightly lower average scores of 4.14 and 4.18, indicating that while the system meets expectations, users feel there is room for improvement in these areas. The consistent scores across dimensions reflect a positive reception, with most users agreeing the system effectively meets its objectives.

Efficiency

Efficiency refers to how quickly and easily users can perform their tasks using suggesting that while users are satisfied with the app, based on the testing, the system demonstrated good efficiency:

Usability Dimension	1	2	3	4	5	WM	Descriptive Interpretation
Time Acceptability	7	9	9	10	67	4.18	Agree
Efficiency of System Operation	7	8	11	9	69	4.21	Agree
App Navigation and Feature	8	8	9	8	62	4.15	Agree

Table 8: Efficiency Ratings of the SMART RAD System

Table 8 shows the respondents' evaluations of the Smart RAD system's efficiency, specifically in terms of time acceptability, operational efficiency, and app navigation. The system's Time Acceptability received an average rating of 4.18, reflecting users' general agreement that the start-up process is reasonable, though some noted minor delays. Efficiency of System Operation was rated slightly higher at 4.21, indicating that users found the system relatively easy to operate during use. Meanwhile, App Navigation and Features scored 4.15, suggesting the mobile app is generally navigable but could benefit from enhancements to improve its ease of use and user experience. Overall, the results highlight the system's satisfactory efficiency but also suggest areas for refinement.

Satisfaction

Satisfaction encompasses users' overall contentment with the system, including their attitudes towards the system's usability, design, and effectiveness:

Usability Dimension	1	2	3	4	5	WM	Descriptive Interpretation
Satisfaction with the System	8	7	10	9	61	4.13	Agree
Recommend to Other Motorcyclists	7	9	11	8	67	4.19	Agree
Confidence While Using the System	7	8	10	9	64	4.16	Agree
Overall Recommend App	8	6	12	8	60	4.12	Agree

Table 9: Satisfaction Ratings of the SMART RAD System

Table 9 shows the respondents' satisfaction with the Smart RAD system, including their likelihood to recommend it and confidence while using it. The highest score, 4.19, was for Recommend to Other Motorcyclists, indicating a willingness among users to endorse the system to others. Confidence While Using the System and Satisfaction with the System scored averages of 4.16 and 4.13, respectively, reflecting users' general agreement that the system is reliable and meets their expectations. The Overall Recommend App dimension received the lowest average rating of 4.12, suggesting that while users are satisfied with the app, its design and functionality could be further improved to enhance overall satisfaction. These findings highlight the system's positive reception but underscore opportunities for increasing user satisfaction.

As such, regardless of how sober someone may feel, they cannot bypass a system designed to detect alcohol levels, ensuring that they are still unable to start a vehicle or engage in activities requiring full motor and cognitive abilities.

CONCLUSION AND RECOMMENDATIONS

The development and testing of the Smart RAD system revealed key usability challenges and opportunities for improvement. Users raised concerns about sensor stability and durability, prompting the team to enhance waterproofing and add protective casings. The system's size and weight were also optimized to improve portability and compatibility with various motorcycle models. Feedback highlighted the need for detailed instructional materials, such as guides or tutorials, to aid in understanding the system's features and installation process. Suggestions for future enhancements included improving the alcohol sensor's sensitivity, integrating helmet fitment adjustments, and adding emergency service features.

To advance the system, upgrading to more advanced, environmentally resilient sensors and implementing redundancy measures is recommended. Helmet compliance detection could be enhanced using higher-resolution sensors or camera-based systems. For the mobile app, integrating GPS, improving the user interface, and adding real-time data logging features would increase engagement and promote safer riding habits.

Broader adoption can be achieved by testing the system with a diverse user base and collaborating with government and safety organizations for regulatory support. Reducing production costs through partnerships and bulk manufacturing will enhance accessibility. Continuous refinement based on user feedback will ensure the system evolves into a fully functional prototype that effectively improves motorcycle safety.

REFERENCES

Annanouch, F. E., Martini, V., Fiorido, T., Lawson, B., Aguir, K., and Bendahan, M. (2021). Embedded Transdermal Alcohol Detection via a Finger Using SnO2 Gas Sensors. Sensors, 21(20), pp. 6852. Retrieved from: https://doi.org/10.3390/s21206852

Campero-Jurado, I., Márquez-Sánchez, S., Quintanar-Gómez, J., Rodríguez, S., and Corchado, J. (2020). Smart Helmet 5.0 for Industrial Internet of Things Using Artificial Intelligence. Sensors, 20(21), pp. 6241. Retrieved from: https://doi.org/10.3390/s20216241

Chibaro, M., Munuhwa, S., Mupfiga, C., and Farai, F. C. (2024, May 10). Human Factors and Road Traffic Safety: An Inquiry into The Causes of Upsurge in Road Traffic Accidents in Harare Metropolitan Province, Zimbabwe. Asian Journal of Multidisciplinary Engineering and Science. Retrieved from: https://www.ajmesc.com/index.php/ajmesc/article/view/779

Choi, Y., and Kim, Y. (2021). Applications of Smart Helmet in Applied Sciences: A Systematic Review. Applied Sciences, 11(11), pp. 5039. Retrieved from: https://doi.org/10.3390/app11115039

Keall, M. D., Frith, W. J., and Patterson, T. L. (2020). The Influence of Alcohol, Age, and Number of Passengers on the Night-Time Risk of Driver Fatal Injury in New Zealand. Accident Analysis & Prevention, 36(1), pp. 49–61. Retrieved from: https://doi.org/10.1016/s0001-4575(02)00114-8

Ospina-Mateus, H., Jiménez, L. A. Q., Lopez-Valdes, F. J., and Salas-Navarro, K. (2019). Bibliometric Analysis in Motorcycle Accident Research: A Global Overview. Scientometrics, 121(2), pp. 793–815. Retrieved from: https://doi.org/10.1007/s11192-019-03234-5

Adafruit Learning System. (2012, November 29). Arduino Lesson 2. LEDs. Retrieved from: https://learn.adafruit.com/adafruit-arduino-lesson-2-leds/resistors

Arduino. (2024, January). Arduino Nano. Retrieved from: https://docs.arduino.cc/hardware/nano/

Eisenman, B. (n.d.). Learning React Native.

Volume 9, Issue 1, 2024
P-ISSN: 2672-2984
E-ISSN: 2672-2992
www.sajst.org

O'Reilly Online Learning. Retrieved from: https://www.oreilly.com/library/view/learning-react-native/9781491929049/ch01.html

GeeksforGeeks. (2024, April 30). Force Sensitive Resistor (FSR) with Arduino. Retrieved from: https://www.geeksforgeeks.org/force-sensitive-resistor-fsr-with-arduino/

Interface One Channel Relay Module with Arduino. (2022, October 10). Last Minute Engineers. Retrieved from: https://lastminuteengineers.com/one-channel-relay-module-arduino-tutorial/

Marks & Harrison. (2022, May 10). 9 Advancements In Motorcycle Safety Technology You Should Know About. Retrieved from: https://www.marksandharrison.com/blog/9-advancements-in-motorcycle-safety-technology-you-should-know-about/

MQ303A Alcohol Sensor. (n.d.). Mouser Electronics. Retrieved from: https://www.mouser.com/datasheet/2/744/MQ303A-766259.pdf

Publications Office of the European Union. (2023). Saving 20,000 Lives on Our Roads: A Shared Responsibility. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/6ea94052-1b87-4921-996d-400615050004

Risk Assessment Model Affecting the Severity of Motorcycle Accidents in Metro Manila. (2020, April 1). IEEE Conference Publication | IEEE Xplore. Retrieved from: https://ieeexplore.ieee.org/document/9102063

Road Traffic Injuries. (2023, December 13). World Health Organization. Retrieved from: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries

Safety Systems in Modern Motorcycles. (2022, November 7). Motorcycle Powersports News. Retrieved from: https://www.motorcyclepowersportsnews.com/safety-systems-modern-motorcycles/

Sensors Modules and Bluetooth. (2024, May). Electronic Wings. Retrieved from: https://www.electronicwings.com/sensors-modules/bluetooth-module-hc-05

Syedzainnasir. (2021, August 15). Introduction to Arduino Uno. The Engineering Projects. Retrieved from: https://www.theengineeringprojects.com/2018/06/introduction-to-arduino-uno.html

Tupas, E. (2022, December 22). Due to Drunk Driving: Road Crashes Up by 90% – HPG. Philstar.com. Retrieved from: https://www.philstar.com/nation/2022/12/23/2232737/due-drunk-driving-roadcrashes-90-hpg

WHO Initiatives. (2022, September). World Health Organization. Retrieved from: https://www.who.int/initiatives/SAFER/drinkdriving