

Development of an Integrated Disaster Detector and Alert System

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ABSTRACT

This study developed and evaluated the Integrated Disaster Detector and Alert System (IDDAS), a multi-functional safety device designed for disaster monitoring, early warning, and emergency response. The system integrates sensing, communication, suppression, and backup features to detect earthquake vibrations, fire, and hazardous gas leaks. Its technical components include a PCB and microcontroller board, vibration sensor, fire sensor, gas fume sensor, horn/buzzer, antenna, SIM card module, water pump, sprinkler system, 12V backup power supply, and protective housing. These integrated components contribute to the system's functionality, durability, and responsiveness. Findings showed that IDDAS demonstrated high effectiveness in sensitivity, audibility, and connectivity. Sensitivity testing achieved a 100% success rate across ten trials for ground vibration, fire, and gas detection, with consistent activation of alarms and SMS alerts. Audibility testing showed 100% sound clarity at 25 and 50 meters, while performance slightly decreased at 75 meters but remained effective. Connectivity testing revealed 100% SMS transmission success at strong signal strength, although performance declined under weaker network conditions. The system received an overall rating of "Very Acceptable" in design, composition, operating performance, and safety, with high mean scores ranging from 4.78 to 4.81. Results confirmed the system's reliability, structural soundness, and suitability for multi-hazard detection. Overall, IDDAS proved to be an effective IoT-based disaster detection and alert system that supports early warning, improves disaster preparedness, and enhances rapid emergency response in real-world settings.

Keywords: Internet of Things (IoT), integrated disaster detector and alert system, early warning, disaster preparedness, ground vibration detection, gas and fire sensing, SMS alert, safety, and reliability.

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INTRODUCTION

Natural and human-induced disasters, such as earthquakes, gas leaks, and fires, continue to pose serious threats to public safety worldwide. Many countries are increasingly vulnerable due to rapid urbanization, high population density, and climate-related risks. Earthquakes, in particular, occur with little or no warning, while fires and gas-related incidents can rapidly escalate if not detected early. As a result, global disaster risk reduction frameworks emphasize early detection, timely communication, and automated response systems to minimize casualties and property damage. These efforts are closely aligned with the United Nations Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities), which aims to make human settlements inclusive, safe, resilient, and sustainable, and SDG 13 (Climate Action), which calls for strengthened resilience and adaptive capacity to climate-related hazards and disasters.

The Sendai Framework for Disaster Risk Reduction 2015–2030 highlights the critical role of science, technology, and innovation in strengthening disaster preparedness and response capabilities (United Nations Office for Disaster Risk Reduction [UNDRR], 2015). Recent international studies have demonstrated that integrated, multi-hazard monitoring systems combining fire, gas, and seismic detection significantly improve emergency response efficiency in residential, commercial, and industrial environments (Kumar & Hancke, 2014). The use of microcontroller-based platforms, such as Arduino, has gained global recognition due to their affordability, flexibility, and ability to integrate multiple sensors into a single system (Reyes, Dizon, & Santos, 2019). These technologies support automated alerts and mitigation actions, reducing reliance on human intervention and minimizing response delays, thereby contributing to SDG 9 (Industry, Innovation, and Infrastructure) through the promotion of resilient and innovative technological solutions.

The Philippines is among the most disaster-prone countries in the world due to its geographic location along the Pacific Ring of Fire and its exposure to various natural and technological hazards. Earthquakes, fires, and gas-related incidents pose continuous risks to communities, institutions, and critical infrastructure (Lagmay et al., 2012). In response to these challenges, the Philippine government enacted Republic Act No. 10121, which institutionalizes a comprehensive, all-hazard, multi-sectoral, inter-agency, and community-based Disaster Risk Reduction and Management (DRRM) framework. This law emphasizes preparedness, early warning systems, mitigation, response, and recovery as key strategies for reducing disaster impacts, in line with the national commitment to achieving the SDGs.

Under RA 10121, early warning systems and structural mitigation measures are recognized as essential components of national disaster preparedness. The integration of earthquake alarms with gas fume and fire detection supports the Act's objective of strengthening hazard monitoring, analysis, and timely communication during emergencies. Moreover, the integration of automated systems such as water sprinklers aligns with mitigation strategies aimed at minimizing disaster-related damage and safeguarding lives and property. The SMS-based alert systems further reinforce the Act's goal of effective communication, particularly in areas with limited internet connectivity, supporting SDG 3 (Good Health and Well-Being) by reducing injury and loss of life during disaster events.

At the local level, disaster preparedness remains a significant challenge, especially for barangays, schools, and small institutions that often rely on manual monitoring and fragmented safety systems. Many local government units (LGUs) and community facilities lack integrated and cost-effective technologies capable of detecting multiple hazards simultaneously. This limitation can delay emergency response, increasing the vulnerability of communities and the risk to lives and property.

The development of a unified disaster detection and alert system offers a practical and sustainable solution to strengthen local DRRM efforts. By providing real-time monitoring of ground vibration, gas fumes, and fire outbreaks, coupled with audible alarms, automatic water sprinklers, and SMS alerts, the system enhances preparedness, response efficiency, and community safety. Such a system supports LGUs, barangay DRRM offices, educational institutions, and commercial establishments in fulfilling their mandates under RA 10121 while advancing the goals of SDG 11, SDG 9, and SDG 13. Furthermore, it promotes collaboration among government agencies, school administrators, private partners, and community stakeholders, contributing to a people-centered, risk-informed, and disaster-resilient local environment.

In view of the increasing frequency and impact of disaster-related incidents and the limitations of existing single-hazard and manually operated safety systems, the researcher proposes the development of an integrated disaster detection and alert device. The primary motivation for this initiative is to provide a cost-effective, reliable, and accessible solution that enables early detection, rapid communication, and immediate response to multiple hazards. By integrating earthquake, gas fume, and fire detection with automated alarms, SMS alerts, and mitigation mechanisms, the proposed device aims to enhance disaster preparedness at the community level, reduce response time, and minimize potential loss of life and property, particularly in resource-limited settings.

Statement of the problem

This study aimed to develop an integrated disaster detection and alert system. Specifically, it sought to achieve the following:

1. Describe the technical features of the Integrated Disaster Detector And Alert System (IDDAS).
2. Determine the sensitivity of the Integrated Disaster Detector and Alert System (IDDAS) in sensing the ground vibration, fume, and fire.
3. Determine the audibility of the Integrated Disaster Detector and Alert System (IDDAS) in terms of varying distances.
4. Determine the connectivity of the device in receiving SMS message alerts in terms of signal.
5. Determine the acceptability of the Integrated Disaster Detector and Alert System (IDDAS) in terms of design, composition, operating performance, and safety.

METHODOLOGY

This study employed a developmental research design that focused on the systematic design and refinement of an Integrated Disaster Detector and Alert System (IDDAS) through iterative cycles of prototyping and evaluation, consistent with the framework proposed by McKenney and Reeves (2019). A comprehensive research approach was used to design, develop, test, and implement an integrated system capable of detecting earthquakes, gas fumes, and fire hazards. The system is equipped with an automatic water sprinkler mechanism and an SMS-based alert feature to enhance timely disaster response. The methodology comprised several interrelated phases, including conceptualization, system design, prototyping, testing, and evaluation, ensuring continuous improvement at each stage of development. The study began with an extensive review of related literature to establish a strong theoretical and technological foundation, enabling the identification of current advancements, best practices,

and practical applications relevant to disaster detection and preparedness systems. Insights gained from this review guided design decisions and the functional integration of system components, ultimately contributing to the development of a reliable and responsive disaster alert solution.

The key design criteria for the IDDAS focused on reliability, sensitivity, and rapid response to ensure safety. The system included sensitive detectors, fire sensors, and gas fume sensors capable of identifying hazards at an early stage, all integrated into a central microcontroller or IoT-based platform for real-time processing. It incorporated a robust alarm mechanism with both audible and visual alerts to immediately warn occupants, while automatically triggering a water sprinkler to suppress fire. The system also incorporated GSM or IoT modules to send instant SMS notifications to homeowners, emergency responders, or authorities, even during power interruptions, through a backup power supply. The design emphasized fail-safe operation, a user-friendly interface, durability for long-term use, and compliance with safety standards to ensure effective disaster preparedness and risk mitigation.

The materials and supplies required for the construction of the IDDAS consisted of the following components, each serving a specific functional purpose within the system. Fifteen resistors were used as passive components to reduce the flow of current in the circuit, while four 2N5551 transistors served as semiconductors capable of switching and amplifying signals. One SIM card functioned as the communication gateway for sending SMS alerts, and two capacitors served as filters for the power supply. Four 5-volt relays acted as electrically operated switches, and one 3D plastic casing served as an enclosure to protect the device components. One switch was included as a manually operated component that opens and closes a circuit, and one AMS117 3.3 IC regulated the supply voltage to 3.3 volts. One Vero board was used for creating prototype products that hold the components in place, while one fuse served as a protection device that interrupts the circuit during overcurrent conditions. One MCU (MicroController Module) functioned as the central unit that coordinates input and output signals. One 3D water nozzle was used to dispense water in spray form, and one DC Pump SV was used to pump water from the source to the sprinkler. Five Light Emitting Diodes were included to emit light and indicate the operational status of the device. One electronics cord was used to connect the device to a laptop for programming. Three meters of soldering wire were used to bond leads of parts to the PCB, one meter of #22 AWG Electronics THHN Wire served as conductors to supply electricity to different branches, and one meter of #24 AWG THHN Wire served as conductors to supply electricity to the controller board and coils of modular contractors. One 12V battery served as a backup power source during power outages, and four #4 bolts with nuts were used to mount the device onto a wall or post.

The tools and equipment used in the development of the IDDAS were likewise carefully selected to support each stage of fabrication and assembly. One soldering iron was used to solder electronic components, and one multimeter was used to measure resistance and voltage output. One long nose plier was used to hold components while soldering, and two screwdrivers were used to drive screws in fastening. One de-soldering pump was used to remove melted lead from the circuit, and one diagonal cutter was used to trim excess component terminals on the board. One programmer was used to install firmware into the hardware components, and one electric drill was used to create holes in the project enclosure.

The fabrication and development of the IDDAS followed a systematic, step-by-step procedure conducted in compliance with Occupational Health and Safety standards. The first step involved designing the schematic diagram of the device. A schematic diagram is a simplified and easily understandable visual representation of a project plan, created using standardized symbols and connecting lines (Freeman, 2018). The developed schematic and electronic layout provided detailed specifications and the proper arrangement of components based on their respective datasheets. This diagram illustrated the correct interconnections

among the circuit components and served as a primary reference for the researchers during the assembly of the device.

The second step involved the procurement and preparation of all materials and tools required to construct the device. Before use, all tools were tested and calibrated to ensure user safety and proper operation. Various tools were utilized during the construction process, including cutting tools such as hacksaws for trimming metal components, driving tools such as standard and Phillips screwdrivers for fastening, and boring tools such as electric drills for creating mounting holes. Different types of pliers, including side-cutting and long-nose pliers, were also employed. A soldering iron was used to solder electronic components onto the PCB and Vero board. Following this, all electronic components were pre-tested using a multimeter to verify their functionality and ensure reliability before assembly. The process of creating the IDDAS began with designing the overall electronic circuit layout and mechanical structure. A 1 square foot plywood board served as the main mounting base for all components. The Microcontroller Unit (MCU) acted as the central control system that coordinates input and output signals. Fire detection and gas fume sensors were connected to the MCU to detect gas fumes and flame presence. Once the circuit design was finalized, PCB fabrication was performed to produce a compact and durable printed circuit board on which electronic components such as resistors, capacitors, and wiring were securely soldered using solder. A 12-volt DC 8-amp power supply provided stable power to all modules, ensuring consistent performance. The SIM800L V3 GSM module was programmed and connected to the MCU to send automatic SMS alerts to registered phone numbers when smoke, fire, or gas fumes were detected. An air horn was attached as an audible alert device for earthquake simulation or alarm signaling. The DC pump solenoid valve (SV) was linked to the MCU and controlled the water sprinkler system, which activates automatically when fire or high smoke levels are detected. Some parts of the enclosure or sensor mounts were created using 3D printing for precise fitting and durability. After assembly, the entire system was tested and calibrated to ensure the sensors respond accurately, the alerts are sent promptly, and the sprinkler activates efficiently, resulting in a fully functional automated safety system for disaster response and prevention.

The third step involved installing firmware on the microchip of the MCU, which required several careful procedures to ensure proper system operation. The microcontroller was properly connected to the computer using a USB cable or an appropriate programming interface. Before uploading the firmware, the necessary drivers and the Integrated Development Environment (IDE), such as Arduino IDE or MPLAB X, were installed to allow communication between the computer and the MCU. The firmware program, which contains the logic for detecting earthquakes, gas leaks, and fire, as well as activating the water sprinkler and sending SMS alerts, was written or loaded into the IDE. The programmer selected the correct board type and communication port within the IDE settings to ensure compatibility. After confirming the hardware connections and verifying that all sensors and modules were properly connected, the firmware was compiled to check for coding errors. Once the code was error-free, it was uploaded or flashed to the MCU by pressing the upload button in the IDE. This process transferred the compiled binary code into the microcontroller's memory. When the upload was complete, the MCU automatically reset and began executing the newly installed firmware. To verify successful installation, the system was powered on, and each sensor and function, including the earthquake sensor, gas detector, flame sensor, water sprinkler actuator, and GSM module, was tested to ensure correct response according to the programmed instructions.

The fourth step involved the systematic assembly of all component parts. The process began by preparing all necessary materials and components, including the MCU, vibration or

earthquake sensor, gas sensor (MQ-2 or MQ-135), flame sensor, water pump or sprinkler mechanism, GSM module, buzzer or alarm, power supply, relay module, jumper wires, and the circuit board or breadboard. The MCU was placed at the center of the circuit setup, as it serves as the main controller managing all input and output operations. The sensors were then connected to the MCU's analog or digital input pins according to their specifications, ensuring that the vibration sensor detects ground motion, the gas sensor senses harmful fumes, and the flame sensor identifies fire or excessive heat. Output components such as the buzzer, water sprinkler (connected through a relay for high-voltage control), and GSM module were wired to the appropriate output pins of the MCU. Proper polarity and voltage ratings were observed during wiring to prevent short circuits or component damage. After all connections were secured, the power supply was attached to energize the circuit through a regulated 5V or 12V adapter depending on the design. The connections were verified using a multimeter to confirm continuity and prevent wiring errors. The assembled circuit was then mounted on a stable platform or enclosed in a protective casing to safeguard it from external damage. A series of initial tests were conducted to ensure that each sensor and output device responded properly, including confirmation that the alarm sounded during vibration or smoke detection, the sprinkler activated when fire was detected, and the GSM module sent alert messages to the designated phone number.

The fifth step involved downloading the application software, registering an account, and adding the device to the system. This process began by connecting a smartphone to the internet and opening the Google Play Store or Apple App Store to search for the specific monitoring or SMS alert application compatible with the device. After downloading and installing the application, the user registered by entering basic information such as name, email address, and phone number to create an account. Upon successful registration, the user logged in and proceeded to add the device by selecting the Add Device or Connect Device option in the application. The system required either scanning a QR code, entering the device's unique ID, or connecting through Bluetooth or Wi-Fi to pair it with the MCU. Once connected, the device was named and configured within the application to display real-time data and send alerts for earthquake, gas leak, or fire detection. The user then tested the connection to ensure that notifications and SMS alerts were properly received, confirming that the device had been successfully added and linked to the application.

The sixth step involved assembling the remaining components of the device. The horn or alarm buzzer was securely mounted in its designated location within the casing and properly connected to the control board or microcontroller to ensure effective sound output during emergencies. The water sprinkler system was installed by attaching the solenoid valve or water outlet to the upper portion of the casing and connecting it to the relay module, which activates the sprinkler upon fire detection. All water connections were tightly sealed to prevent leakage. The internal wiring, sensors, and modules were carefully arranged and mounted inside the project enclosure, ensuring that each component was firmly secured and properly organized to prevent short circuits and loose connections. All terminals and power connections were thoroughly inspected before closing the casing to ensure safety and reliable system operation.

The seventh and final step involved final testing and calibration. The system was powered on, and all indicator lights and components were verified for proper function. Each sensor was tested individually: the vibration sensor was gently shaken to simulate an earthquake, the gas sensor was exposed to a small amount of gas, and controlled heat or fire was applied near the fire sensor within a three-foot radius. The corresponding alarms, water sprinkler, and SMS alerts were observed to ensure proper activation. The sensitivity levels of each sensor were adjusted through the control settings or calibration pins to ensure accurate detection without false alarms. After testing all functions, it was verified that SMS notifications were sent promptly to the registered phone number. Once all components responded correctly

and consistently, the device cover was secured, and the system was confirmed ready for full operation. The internal electrical components were rechecked before the device was connected to a power source. To further enhance safety, a multimeter was utilized to test for electrical leakage between the electrical box and exposed metal parts, with a range of 100 k Ω selected to ensure that no electrical leakage was present in the device.

The overall operational logic of the IDDAS followed a clearly defined sequence. The development process began with preparing all required materials, tools, and components such as sensors, relays, microcontrollers, and power sources. A plywood board was cut to serve as the base, and the circuit layout was carefully planned for proper component placement. The components were soldered onto the PCB and Vero board, and essential parts including the relay, earthquake sensor, gas and fire sensors, alarm system, battery, and Arduino Nano were installed. The system was programmed using a laptop to process sensor data, trigger alarms and the water sprinkler, and send SMS alerts via a registered SIM card. After programming, the device underwent testing and evaluation to ensure accurate and reliable performance. Once verified, the device was packaged and turned over to the end user for real-world emergency applications.

The operational process of the IDDAS utilized sensors and GSM communication for real-time monitoring and emergency response. Upon system startup, the GSM module was initialized and a component test was performed to ensure that all modules were functioning properly. Once initialization was complete, the system continuously monitored data from the vibration, fire, and gas sensors. The system first evaluated the vibration sensor, and if the vibration count within three seconds exceeded the predetermined threshold, an earthquake was detected. In response, the system activated the air horn, sent an earthquake alert SMS, and initiated a cooldown period to prevent repeated notifications. The fire sensor was then assessed, and if the sensor reading exceeded the specified threshold, a fire was detected, prompting the system to activate the water pump and send a fire alert SMS. The gas sensor was subsequently evaluated, and if the detected gas concentration exceeded the threshold, a gas leak was identified, causing the system to activate the buzzer and send a gas leak alert SMS. After all sensors had been checked, the system applied a cooldown mechanism to avoid message flooding, waited for a 50-millisecond delay, and then repeated the monitoring cycle continuously to ensure uninterrupted real-time surveillance and rapid emergency response.

The device was evaluated through actual performance testing and assessment by evaluators using a researcher-made questionnaire. The questionnaire was validated by experts and members of the research advisory committee to ensure its reliability and relevance. Testing was carried out by officers from the Philippine Institute of Volcanology and Seismology (PHIVOLCS), the Department of Science and Technology (DOST), and the Bureau of Fire Protection (BFP), as well as officers from the Provincial Disaster Risk Reduction and Management Office (PDRRMO), the City Disaster Risk Reduction and Management Office (CDRRMO), academic professors, and end users. Multiple rounds of testing were conducted to achieve optimal performance of the IDDAS, employing a trial-and-error approach and integrating the insights of the experts at each stage.

The research instruments used in the study included direct observations and a researcher-made observation sheet. Before the evaluation by thirty (30) evaluators, the researchers presented the questionnaire to the advisory committee and the research committee for validation. Feedback and suggestions were recorded to make necessary revisions. Different trials were conducted on the device to test its connectivity, sensitivity, and audibility. For connectivity, the device's ability to send alerts for earthquake, gas fume, and fire detection was tested, with notifications observed at five-second intervals per trial over ten (10) trials to

determine whether they were successfully sent to the registered mobile phone. For sensitivity, the earthquake detection function was tested at five-second intervals per trial over ten (10) trials to evaluate the device's response to ground vibrations. For audibility, the device was tested at five-second intervals per trial over ten (10) trials to measure how effectively the alarm could be heard at three different distances, ensuring that the alarm could alert the community effectively during emergencies. The level of acceptability of the product was assessed based on five factors: technical features, design, composition, operating performance, and safety, rated using the evaluation sheet.

The data gathering procedure involved a series of direct observations while operating the IDDAS using a smartphone. To determine the sensitivity of the IDDAS in detecting ground vibrations, the device was tested by tapping its casing to simulate movement, with results recorded using binary scoring in which a score of 1 indicated that the device successfully responded by activating the alarm, while a score of 0 indicated no response. The procedure was repeated ten (10) times to ensure reliability of the findings. To assess the clarity and audibility of the alarm at different distances, the device was tested at 25, 50, and 75 meters, with results likewise recorded using binary scoring in which a score of 1 indicated that the alarm was clearly audible at the specified distance and a score of 0 indicated that it was not audible. This test was also conducted ten (10) times to ensure consistency and reliability. To evaluate the connectivity of the IDDAS in transmitting alerts for ground vibration, gas fumes, and fire detection, SMS notifications were tested under signal strengths of 1, 2, 3, and 4 bars in both open and enclosed areas. A score of 1 was assigned when the device successfully sent an SMS alert that was promptly received by the registered mobile phone, while a score of 0 was assigned when the alert was not received, with each signal strength condition tested ten (10) times.

To assess the overall acceptability of the device, a researcher-designed questionnaire was administered to thirty (30) evaluators. Fifteen (15) were industry evaluators, including three licensed electrical engineers, four electrical professors, four electronics professors, one CapSU Main DRRM focal person, one PHIVOLCS officer, three Provincial DRRM officers, three DOST-licensed engineers, three Roxas City DRRM personnel, and four research examining committee members. Additionally, two (2) education professors and two (2) end-user evaluators, consisting of a house occupant and a homeowner, participated in the assessment. This diverse group of evaluators provided a comprehensive assessment by integrating perspectives from technical experts, academic professionals, disaster management practitioners, and potential users.

The parameters used to evaluate connectivity were assessed using the device and a smartphone with the device's application installed, along with a SIM card. A registered phone number was connected to the device to test its ability to send message alerts accurately. Connectivity was analyzed based on signal strength measured as 1, 2, 3, or 4 bars. A rating of 1, interpreted as Connected, was assigned when the device sent an SMS alert that was quickly received by the registered cellphone, while a rating of 0, interpreted as Not Connected, was assigned when the SMS alert was not received by the registered cellphone. The audibility of the alarm was tested at distances of 25 meters, 50 meters, and 75 meters, with 10 trials conducted at each distance. In scoring the audibility of the alarm at three varying distances, binary scoring was likewise applied: a rating of 1, interpreted as Audible, was assigned when the device alarm could be heard, while a rating of 0, interpreted as Not Audible, was assigned when the device alarm could not be heard.

In determining the general acceptability of the device in terms of technical features, design, composition, operating performance, and safety, five response categories were used. A score of 5, corresponding to a mean score range of 4.21 to 5.00, was interpreted as Very Acceptable. A score of 4, corresponding to a mean score range of 3.41 to 4.20, was interpreted as Acceptable. A score of 3, corresponding to a mean score range of 2.61 to 3.40, was

interpreted as Moderately Acceptable. A score of 2, corresponding to a mean score range of 1.81 to 2.60, was interpreted as Less Acceptable. A score of 1, corresponding to a mean score range of 1.00 to 1.80, was interpreted as Least Acceptable. The mean was calculated and used to determine the level of general acceptability of the IDDAS in terms of design, composition, operating performance, and safety.

The cost of the materials used for the development of the IDDAS, together with the total labor cost, was determined through a comprehensive cost analysis. Twenty resistors were procured at P3.00 each for a total of P60.00. Four 2N5551 transistors were acquired at P10.00 each, totaling P40.00. One SIM card was purchased at P50.00, and two capacitors were obtained at P3.00 each for P6.00. Four 5-volt relays were sourced at P25.00 each, amounting to P100.00, while one 3D plastic casing was acquired at P1,500.00. One switch was purchased at P75.00, and one AMS117 3.3 IC was obtained at P20.00. One MCU (Microcontroller Module) was procured at P485.00, and one fuse was purchased at P8.00. One 3D water nozzle was acquired at P160.00, and one DC Pump SV was obtained at P405.00. One 5V SMPS was purchased at P80.00, and one Light Emitting Diode was obtained at P3.00. Five electronics cords were acquired at P5.00 each for a total of P25.00, and three meters of soldering wire were purchased at P15.00 per meter for P45.00. Four meters of #22 AWG Electronics THHN Wire were obtained at P32.00 per meter, totaling P128.00, while three meters of #24 AWG THHN Wire were purchased at P25.00 per meter for P75.00. One set of 12V battery was acquired at P1,200.00, and four #4 bolts with nuts were purchased at P15.00 each for P60.00. The total cost of materials amounted to P4,525.00. Labor cost was computed at 40% of the total cost of materials, equivalent to P1,810.40, yielding a total cost of the product of P6,335.00.

RESULTS AND DISCUSSION

This chapter presents the analysis and interpretation of data gathered in the study of the Integrated Disaster Detector and Alert System (IDDAS), covering its technical features, sensitivity, audibility, connectivity, and overall acceptability across multiple evaluative dimensions.

The Integrated Disaster Detector and Alert System is a multi-functional safety device designed with integrated sensing, communication, suppression, and backup features for disaster monitoring and response. Its technical components include a PCB and microcontroller board that serves as the central processing unit, receiving, analyzing, and controlling signals from the system's sensors and components. The system incorporates a vibration sensor for detecting ground movement associated with seismic activity, a fire sensor and detector for identifying flames or excessive heat, and a gas fume sensor for monitoring hazardous or combustible gases in the environment. These sensing components enabled the device to effectively detect multiple hazards and respond promptly to emergency conditions. For alert and communication functions, the system is equipped with a horn and buzzer that produces audible warning signals, an antenna that strengthens cellular signal transmission, and a SIM card module that enables the device to send emergency SMS notifications to users, thereby enhancing the reliability and timeliness of warning dissemination. For fire response, the device includes a water pump for transferring water under pressure, a water container for storing a water supply, and a sprinkler head for dispersing water to suppress fire, all of which contribute to the system's capability to provide immediate initial fire control. To ensure continuous operation during power interruptions, the system is supported by a 12V backup power supply, which provides alternative electrical power when the main source fails, with findings showing improved operational continuity during outages. The device is enclosed in a 3D plastic housing that

secures internal electronic parts, reinforced by a plywood casing for structural protection, and a transparent PVC cover that allows visual inspection while shielding components from dust and damage. A manual switch is also included to allow user control and emergency override of automated functions. The integration of these structural and control components improved durability, user accessibility, and overall system reliability. Collectively, these integrated parts and components enable IDDAS to function as a reliable, self-contained disaster detection and alert system for multi-hazard preparedness and response.

The device's protective enclosure safeguards internal components, while the SMS alert module is isolated from high-voltage areas to prevent electrical interference or hazards. The control unit incorporates safeguards against overheating and electrical fires, enhancing overall reliability. All components are assembled and tested according to safety standards, making the device suitable for continuous use in homes, schools, or other establishments. The alarm speaker delivers a loud yet safe sound, ensuring effective alerts without risking hearing damage. For fire and gas hazards, the gas sensor is encased in flame-retardant material, and the circuit board is housed in a waterproof and dust-proof enclosure to maintain functionality and durability. A clear operating manual is provided to ensure proper handling and safe use by the end user.

With respect to the sensitivity of the IDDAS in terms of sensing ground vibrations, the system was evaluated across ten trials. In all ten trials conducted, the system successfully detected ground vibrations, as indicated by a value of 1 in each trial, yielding a total score of 10 and an overall rating of Sensitive. According to the scoring legend, a value of 1 indicates that the device responded through both an alarm and an SMS alert, while a value of 0 indicates no response. The consistent detection across all trials demonstrates the system's high sensitivity and reliability in identifying ground vibrations, indicating that the device is capable of promptly responding to vibration-related events and making it effective for early warning and disaster preparedness. These findings imply that the IDDAS has strong potential as a reliable early warning device for earthquake-related hazards. The perfect detection rate across all ten trials suggests that the system can effectively recognize vibration events and initiate immediate response actions through alarm activation and SMS alerts. This reliability has important implications for improving disaster preparedness, particularly in homes, schools, and communities where timely warnings can help reduce risks, support faster evacuation, and enhance overall safety. The results also indicate that integrating vibration sensing with communication features strengthens the practical value of the system as a responsive disaster mitigation tool, and that low-cost, microcontroller-based systems can serve as effective alternatives or supplements to conventional warning systems, particularly in localized areas. These findings are supported by previous research. Ibrahim, Ahmad, and Hassan (2016) reported that ground vibration sensors integrated with alarm and communication modules demonstrated high reliability when consistent detection was observed across repeated trials. Similarly, Wang et al. (2019) emphasized that early warning systems equipped with vibration sensors are effective in disaster preparedness when they can promptly trigger alerts such as alarms and SMS notifications upon detecting seismic activities. In a related study, Garcia and Lopez (2021) found that integrated detection systems with vibration sensors achieved high sensitivity and responsiveness, which are critical for timely evacuation and risk mitigation. In line with these studies, the IDDAS in the present research consistently detected ground vibrations in all ten trials, confirming its reliability and effectiveness as an early warning device.

Regarding the sensitivity of the IDDAS in terms of sensing gas fumes, ten consecutive trials were conducted. The system successfully detected the presence of gas fumes in all trials, as indicated by a value of 1 for each trial, yielding a total score of 10 and a corresponding overall rating of Sensitive. In this dimension, a value of 1 indicates that the device responded

through an SMS notification confirming gas detection, while a value of 0 indicates no such response. The consistent detection in every trial demonstrates the reliability and high sensitivity of the system's gas fume sensor, indicating that the device can detect gas fumes accurately and promptly, which is essential for early warning and disaster prevention. These findings imply that the IDDAS has strong potential as a reliable safety device for detecting gas-related hazards, with the perfect detection rate across all ten trials confirming that the system can provide prompt warnings through its alert mechanisms, which is essential for preventing accidents such as gas leaks, fires, or explosions. The results suggest that the system can contribute to improved disaster preparedness, enhanced safety, and early hazard mitigation in residential, educational, and commercial settings, and that low-cost, microcontroller-based systems can serve as practical alternatives or supplements to conventional gas detection and warning systems. These results are supported by earlier findings. Kumar and Reddy (2018) stated that gas sensor-based detection systems demonstrating consistent performance across repeated trials are considered highly reliable for early warning applications. Al-Habaibeh et al. (2017) emphasized that high sensor sensitivity is crucial in detecting hazardous gas fumes promptly, thereby minimizing risks and preventing potential disasters. Santos and Cruz (2020) found that integrated disaster detection systems with gas sensors achieved improved accuracy and responsiveness when sensors consistently detected gas presence during multiple testing phases. In line with these studies, the IDDAS successfully detected gas fumes in all ten trials, confirming its reliability and effectiveness as an early warning device for gas fume-related hazards.

In terms of the sensitivity of the IDDAS in sensing fire, the system was likewise evaluated across ten trials. The system successfully detected fire in all ten trials, each recording a score of 1, resulting in a total score of 10 and an overall rating of Sensitive. In this dimension, a value of 1 indicates that the device responded by sending an SMS alert upon detecting fire, while a value of 0 indicates no response. The consistent response across all trials demonstrates the high sensitivity and reliability of the system's fire detection mechanism, confirming the device's capability to promptly identify fire incidents and issue immediate SMS alerts, which is essential for early warning and rapid response. These findings imply that the IDDAS has a highly dependable fire detection mechanism capable of consistently identifying fire incidents and immediately triggering SMS alerts, thereby strengthening its effectiveness as an early warning and emergency response device. The system's perfect detection performance across all trials suggests that it can enhance disaster preparedness by reducing delays in fire incident reporting, improving response time, and potentially minimizing damage to life and property. The results further indicate that integrating automated fire sensing with real-time communication features can significantly improve the practical functionality of disaster detection systems, particularly in residential, educational, and commercial settings. These results are supported by previous research. Chen et al. (2018) found that fire detection systems equipped with reliable sensors and SMS-based alert mechanisms demonstrated high sensitivity when consistently detecting fire in repeated trials. Patel and Shah (2019) reported that early fire warning systems that automatically send SMS notifications significantly improved response time and reduced potential fire-related damage. Dela Cruz et al. (2021) emphasized that the reliability of fire detection systems is enhanced when sensors consistently generate accurate alerts during repeated fire exposure tests. In line with these studies, the IDDAS exhibited consistent sensitivity in all ten trials, confirming its effectiveness and dependability in detecting fire incidents and providing timely SMS alerts.

With respect to the audibility of the IDDAS in terms of sound clarity at varying distances, the system was tested across three distances, namely 25 meters, 50 meters, and 75 meters, with ten trials conducted at each distance. In this dimension, a value of 1 indicates that

the device alarm could be heard clearly, while a value of 0 indicates that it could not be heard clearly. At a distance of 25 meters, all ten trials recorded a score of 1, yielding a total score of 10 and a remark of Audible. Similarly, at 50 meters, all ten trials likewise recorded a score of 1, resulting in a total score of 10 and a remark of Audible. At 75 meters, eight out of ten trials recorded a score of 1, with two trials recording a score of 0, yielding a total score of 8 and an overall remark of Audible. Although a slight decrease in sound clarity was observed at this farther distance, the overall remark remains Audible, suggesting that the alarm can still be heard but with reduced consistency compared to shorter distances. These results indicate that the IDDAS is highly effective in delivering audible alerts up to 50 meters and remains functional at 75 meters, with the reduced audibility at longer distances potentially influenced by environmental factors such as sound attenuation, obstacles, or background noise affecting sound propagation. These findings align with previous research. McLoughlin (2018) noted that alarm systems are most effective at short to moderate distances, as sound clarity diminishes with increased range due to attenuation and environmental factors. Sorensen (2020) emphasized that clear and reliable alarms within critical zones are essential for prompt emergency response. The slight decrease in audibility at 75 meters is also consistent with Murphy and Hall (2019), who reported that obstacles, ambient noise, and sound dispersion can reduce alarm clarity at longer distances. Overall, these findings support the effectiveness of the IDDAS in providing audible alerts within its operational range.

Concerning the connectivity of the IDDAS in receiving SMS earthquake detected alerts in terms of signal strength, the system was evaluated across four signal bar levels, with ten trials conducted at each level. In this dimension, a value of 1 indicates that the device sends an SMS alert that is quickly received by the registered cellphone, while a value of 0 indicates that the alert is not received. At 1-bar signal strength, the system successfully transmitted and delivered SMS alerts in 5 out of 10 trials, yielding a 50% success rate and reflecting unreliable connectivity under very weak signal conditions. At 2-bar signal strength, successful SMS receipt increased to 7 out of 10 trials, corresponding to a 70% success rate and suggesting moderate but still inconsistent connectivity. At 3-bar signal strength, the system demonstrated better performance with 8 successful transmissions, representing an 80% success rate and reflecting improved reliability as signal strength increased. At 4-bar signal strength, the system achieved a 100% success rate, with all 10 trials resulting in successfully delivered SMS alerts promptly received by the registered cellphone. The overall remark across all signal levels was Connected. These findings indicate that the system's SMS alert functionality is highly dependent on signal strength, performing most reliably under strong network conditions and becoming progressively less dependable as signal strength weakens. These results are consistent with related literature. Goldsmith (2015) and Rappaport (2017) stated that wireless communication performance, including SMS delivery, is highly dependent on signal quality, with weaker signals resulting in higher transmission delays and message loss. Chen et al. (2014) reported that SMS success rates significantly improve as signal strength increases, particularly in emergency notification systems. The observed 50% success rate at 1-bar aligns with Kumar and Prakash (2016), who noted that very weak network conditions often lead to unstable and unreliable message delivery. The International Telecommunication Union further states that optimal network conditions are critical for real-time emergency communication systems. Overall, the results affirm that the effectiveness of SMS-based disaster alert systems is highly dependent on network signal strength, reinforcing the importance of deploying such systems in areas with stable and strong cellular coverage.

With regard to the connectivity of the IDDAS in sending SMS gas leak detected alerts in terms of signal strength, the system was evaluated across the same four signal bar levels, with ten trials at each level using the same scoring legend. At 1-bar signal strength, the system successfully sent and delivered SMS alerts in 5 out of 10 trials, resulting in a 50% success rate,

reflecting unstable and unreliable connectivity under weak network conditions. At 2-bar signal strength, the system achieved 8 successful transmissions out of 10 trials, corresponding to an 80% success rate and showing substantial improvement in connectivity and message delivery reliability. At 3-bar signal strength, the system maintained an 80% success rate with 8 successful transmissions, indicating consistent and dependable performance under moderate signal conditions. At 4-bar signal strength, the system demonstrated optimal performance, with all 10 trials yielding a 100% success rate and SMS alerts promptly received by the registered cellphone. The overall remark across all signal levels was Connected. These findings show that the system's ability to transmit gas leak SMS alerts improves as signal strength increases, with the highest reliability observed under strong network conditions and reduced performance under weak signal environments. Rappah (2015) emphasized that weak cellular signals significantly affect data transmission reliability, often resulting in delayed or failed message delivery. Kumar and Prakash (2016) found that emergency SMS notifications transmitted under poor network conditions showed inconsistent performance, with success rates increasing as signal strength improved. Chen, Huang, and Lee (2014) reported that SMS-based hazard and gas monitoring systems achieved higher delivery accuracy and faster response times under moderate to strong signal conditions, consistent with the 80% success rate observed at 2 and 3 bars. The 100% success rate at 4 bars aligns with the findings of the International Telecommunication Union (ITU, 2018), which stated that strong and stable network coverage is essential for real-time disaster and gas leak alert systems. These related studies reinforce the conclusion that the effectiveness and reliability of gas leak SMS alert systems are highly dependent on cellular signal strength.

Regarding the connectivity of the IDDAS in sending SMS fire detected alerts in terms of signal strength, the system was similarly evaluated across four signal bar levels with ten trials at each level. At 1-bar signal strength, the system recorded six successful transmissions out of ten trials, resulting in a 60% success rate, indicating unstable connectivity and unreliable SMS delivery under weak network conditions. At 2-bar signal strength, the success rate improved to 80%, with eight out of ten trials successfully connected, reflecting better but still occasionally inconsistent performance. At 3-bar signal strength, the system demonstrated high reliability with nine successful transmissions, corresponding to a 90% success rate and suggesting that moderate signal strength is sufficient for near-consistent SMS alert delivery. At 4-bar signal strength, the system attained a 100% success rate, with all ten trials successfully transmitting SMS alerts promptly received by the registered cellphone. The overall remark across all signal levels was Connected. Overall, the findings indicate that the effectiveness of the system's fire detection SMS alert is strongly influenced by signal strength, with optimal and fully reliable performance observed under strong network conditions and reduced reliability as signal strength weakens. These findings are supported by related studies. Khyong (2015) explained that weak cellular signal conditions often lead to packet loss and delayed message delivery, consistent with the unstable performance observed at 1-bar. Kumar and Prakash (2016) found that fire and hazard alert systems using GSM technology showed improved SMS delivery rates as signal strength increased, with moderate signals providing near-consistent transmission similar to the 80% to 90% success rates observed at 2 and 3 bars. Chen et al. (2014) found that SMS-based fire alarm systems achieved optimal performance under strong network conditions, consistent with the 100% success rate recorded at 4 bars. The International Telecommunication Union (ITU, 2018) further highlighted that reliable cellular connectivity is a critical factor in the effectiveness of real-time emergency communication systems, particularly for fire detection where timely alerts are essential.

In terms of the acceptability of the IDDAS with respect to design, the system was assessed using ten indicators evaluated by respondents. The overall mean rating was 4.80, classified as Very Acceptable based on the interpretive scale wherein a mean of 4.21 to 5.00 corresponds to Very Acceptable, 3.41 to 4.20 to Acceptable, 2.61 to 3.40 to Moderately Acceptable, 1.81 to 2.60 to Less Acceptable, and 1.00 to 1.80 to Least Acceptable. The three highest-rated indicators were the proper arrangement and secure fastening of components and the system's compact structure and efficient layout, both with a mean of 4.88, rated Very Acceptable, followed by the appropriateness of the design for a multi-detection system with a mean of 4.86, also rated Very Acceptable. Other indicators included the design's effectiveness in strengthening sensitivity through movement and ground shaking while detecting fire and gas fumes, with a mean of 4.83; the design's adaptability to various residential, school, and commercial settings and the appropriate inclusion of water sprinkler activation in the system, both with a mean of 4.81; the design's portability and ease of installation with power backup support and its uniqueness with improved sensitivity in the control system, both with a mean of 4.79; the design's precautionary measures for the safety of parts and accessories with a mean of 4.69; and the device's built-in capability for smarter design and versatile use with a mean of 4.64, all rated Very Acceptable. These results indicate that respondents highly valued the physical organization, stability, and structural integrity of the device, with well-arranged and securely mounted components contributing significantly to user confidence, durability, and operational reliability. The compact and efficient design implies that the system is practical for installation and use in various settings, making it more adaptable and user-friendly. These findings are supported by Pramono et al. (2019), who noted that effective component integration and stable hardware assembly contribute significantly to the reliability and acceptability of microcontroller-based disaster warning systems, and by Wu and Mittal (2021), who emphasized that compact system architecture and dependable sensor integration improve both performance and practical usability in early warning technologies. These results further align with the study of Villanueva (2020), which emphasized that disaster preparedness devices with integrated features such as hazard detection, compact design, and user-friendly installation gain higher acceptability ratings due to their reliability, versatility, and practicality in various settings.

With respect to the acceptability of the IDDAS in terms of composition, the system likewise received an overall mean rating of 4.80, classified as Very Acceptable using the same interpretive scale. The three highest-rated indicators were the assurance that all components are quality-tested and safeguarded to ensure precise and reliable assembly, and the proper alignment of parts and components following the schematic diagram, both with a mean of 4.88 and rated Very Acceptable, followed by the careful planning and assembly of components with a mean of 4.86, also rated Very Acceptable. Additional indicators included the local availability of components with a mean of 4.83; the programmable wireless module's engineering for efficient IoT integration and the serviceability and replaceability of parts, both with a mean of 4.81; the device's composition of electronic parts functioning according to intended purpose and its professional execution, both with a mean of 4.79; the appropriate mounting of casing and framing to ensure protection against excessive vibration with a mean of 4.69; and the device's provision of standard instructions to ensure correctness of operation with a mean of 4.64, all rated Very Acceptable. These findings indicate that respondents placed strong confidence in the accuracy, safety, and dependability of the system's construction, recognizing that quality-tested components and correct alignment are critical in ensuring stable operation and reducing the risk of malfunction. The results imply that maintaining high standards in component testing, schematic accuracy, and assembly planning can enhance user confidence and support the broader adoption of IDDAS. These findings are supported by Pramono et al. (2019), who found that accurate component integration and careful assembly improve

reliability and functional performance in Arduino-based warning systems, and by Chandrakumar et al. (2022), who highlighted that quality-tested components and proper system configuration are fundamental in ensuring dependable operation in low-cost disaster detection devices. The results also align with Santos (2019), who emphasized that disaster detection systems with quality-tested components, proper assembly, and locally available and serviceable parts achieve higher acceptability due to their reliability, practicality, and ease of maintenance.

Concerning the acceptability of the IDDAS in terms of operating performance, the system received an overall mean rating of 4.78, interpreted as Very Acceptable using the same scale. The three highest-rated indicators were the device's ability to actively detect vibration and provide an alarm with a mean of 4.90, rated Very Acceptable, followed by accurate multi-hazard detection and the speedy activation of the water sprinkler upon fire detection, both with a mean of 4.83 and rated Very Acceptable. Other indicators included the consistent and timely delivery of SMS alerts with a mean of 4.83; the system's reliable performance under various test conditions, its operability at any time of day with loud and noticeable sound upon detecting movement, and the smooth and efficient coordination between detection, alarm, and response mechanisms, all with a mean of 4.79; the system's effective operation across all functions with a mean of 4.76; the functional integration of the SMS alert for real-time response with a mean of 4.71; and the ease of operating the system as an integrated earthquake alarm, gas fume, and fire detection system with a water sprinkler and SMS alert with a mean of 4.60, all rated Very Acceptable. These results indicate that respondents perceived rapid detection, accurate hazard recognition, and prompt response mechanisms as critical strengths contributing to the system's operational reliability and effectiveness. These findings are supported by Pramono et al. (2019), who noted that rapid vibration detection and immediate alarm activation are essential features enhancing the effectiveness of localized early warning systems, and by Yanti and Suprpto (2020), who highlighted that accurate hazard sensing and automated response mechanisms significantly improve preparedness and response efficiency. The results further align with Del Rosario (2021), who highlighted that disaster detection systems with reliable multi-hazard sensing, rapid response mechanisms, and real-time alert integration are highly acceptable due to their efficiency and practicality in emergency preparedness.

Finally, with regard to the acceptability of the IDDAS in terms of safety, the system received an overall mean rating of 4.81, interpreted as Very Acceptable using the same scale. The three highest-rated indicators were the careful assembly and secure connection of electrical and electronic parts to ensure safe and reliable operation with a mean of 4.86, rated Very Acceptable, followed by safe operation restricted to authorized users and the secure enclosure protecting parts and components, both with a mean of 4.83 and rated Very Acceptable. Additional indicators included the isolation of the SMS alert module from high-voltage components to reduce the risk of electrical interference or user harm, and the control unit's protection from overheating or electrical fires, both with a mean of 4.83; all components being tested and assembled following safety standards with a mean of 4.81; the alarm speaker's design to alert users without damaging their hearing, also with a mean of 4.81; the gas sensor's enclosure in a flame-retardant casing to prevent ignition with a mean of 4.79; the circuit board's enclosure in a waterproof and dust-proof housing with a mean of 4.79; and the device's provision of an operating manual for the safety of the end user with a mean of 4.71, all rated Very Acceptable. These results suggest that respondents highly valued protective design measures, secure construction, and controlled operation as essential elements of a safe and dependable disaster detection system. These findings are supported by Wu and Mittal (2021), who noted that secure hardware integration and protected system architecture are essential in

improving the dependability and safe operation of low-cost early warning devices, and by Chandrakumar et al. (2022), who emphasized that proper electrical protection, controlled system design, and durable enclosures are critical in reducing operational risks and ensuring long-term reliability. The results further align with Garcia (2020), who emphasized that disaster detection systems designed with strict adherence to safety standards, including secure electrical connections, protective enclosures, flame-retardant casings, and isolation of sensitive modules, are more acceptable because they minimize risks to users while ensuring continuous reliability.

CONCLUSION

The developmental research study on the Integrated Disaster Detector and Alert System (IDDAS) established that the device is a reliable and effective disaster preparedness innovation capable of supporting early detection and rapid response to multiple hazards, including earthquakes, fire, and gas leaks. Conducted among 30 participants composed of industry evaluators, research examining committee members, education professors, and end user evaluators, the study confirmed that the system successfully integrated sensing, communication, suppression, backup power, and structural components into a unified and self-contained disaster detection and alert mechanism. The findings demonstrated that the vibration, fire, and gas fume sensors consistently performed with high accuracy and sensitivity, while the horn or buzzer, antenna, and SIM card module ensured timely dissemination of audible alarms and SMS notifications. Likewise, the incorporation of fire suppression components such as the water pump, water container, and sprinkler contributed to immediate initial fire control, while the 12V backup power supply maintained uninterrupted functionality during power outages. The structural components, including the 3D plastic housing, plywood casing, transparent PVC cover, and manual switch, further enhanced the durability, accessibility, protection, and operational control of the device, thereby strengthening its reliability and practicality for disaster preparedness applications.

The study further revealed that the IDDAS possessed highly functional technical features that allowed users to configure and control the system through a software application installed on a laptop even without internet connectivity. The compact structure, organized component arrangement, and securely fastened parts contributed to the stability and ease of operation of the device. In addition, the use of quality tested and safeguarded components ensured reliable assembly and consistent system performance. The system effectively detected ground vibrations and accurately identified hazards such as fire and gas fumes, while maintaining secure electrical connections and protecting internal components from damage and unauthorized access. These operational characteristics demonstrated that the IDDAS was capable of sustaining safe and stable performance under varying conditions, which reinforced its suitability as a dependable disaster detection and alert system.

The evaluation of the system's sensitivity confirmed that the IDDAS exhibited a very high level of responsiveness in detecting hazards. The device achieved a perfect score of 10 across all trials involving ground vibrations, gas fumes, and fire detection, which indicated that the system consistently activated alarms and SMS notifications whenever threats were identified. Moreover, the assessment of audibility revealed that the warning alarm remained fully audible at distances of 25 and 50 meters and generally audible at 75 meters despite a slight reduction in clarity. These findings verified that the system could effectively warn nearby individuals during emergency situations, thereby enhancing its function as an early warning mechanism for disaster preparedness and response.

In terms of connectivity, the study established that the effectiveness of SMS alert transmission was dependent on network signal strength. The system demonstrated the highest level of performance under strong signal conditions with a 100% success rate in message

delivery at four signal bars. Under moderate signal conditions ranging from two to three bars, delivery rates improved to 70% to 90%, while very weak signal conditions with one signal bar resulted in only 50% to 60% success, indicating unreliable connectivity. Despite this limitation, the findings confirmed that the system remained highly functional under stable signal conditions and could effectively deliver prompt notifications to intended recipients. Furthermore, the overall acceptability evaluation revealed that the IDDAS was rated Very Acceptable in terms of design, composition, operating performance, and safety, reflecting strong approval from evaluators regarding the functionality, practicality, and reliability of the innovation.

Overall, the findings of the study demonstrated that the Integrated Disaster Detector and Alert System possess significant potential to strengthen disaster risk reduction and emergency preparedness initiatives. The system's reliable hazard detection capability, efficient alarm and notification functions, dependable operating performance, and robust safety features support its applicability in residential and commercial settings. The results also suggest that the IDDAS can contribute to improved community safety and resilience against both natural and man-made hazards through timely warning and response mechanisms. In view of these findings, it is recommended that the system be continuously improved, tested, and implemented in wider applications to maximize its effectiveness. The incorporation of more advanced sensors with higher sensitivity and reliability may further improve detection accuracy and response time, while the integration of Internet of Things technology and renewable energy sources such as solar power may enhance sustainability and ensure continuous operation during power interruptions. Optimization of the SMS alert feature is also recommended to facilitate real time communication among homeowners, building administrators, and emergency responders for more efficient coordination during emergencies. Moreover, government agencies, schools, and private institutions are encouraged to support and adopt the system as part of their disaster risk reduction and management programs. Public awareness initiatives, user training, and regular maintenance activities should likewise be conducted to ensure proper operation and long-term reliability of the device. Future researchers are further encouraged to continue enhancing the innovation to strengthen community resilience and improve protection against disaster related threats.

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