

Smart Safety System: Arduino Uno-integrated door for fire and smoke alerts

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Abstract

This study aimed to develop an Arduino Uno-integrated door for gas and smoke alerts to enhance fire safety and facilitate efficient evacuation. Current automatic door systems typically rely on motion sensors to trigger opening. In this prototype system, the door automatically opens based on smoke levels, with each level corresponding to a series of automated actions. The researchers utilized an experimental research design and applied research. The materials used are as follows: Arduino Uno, buzzers, LED lights, LCD, MQ135 gas sensors, servo motors, and stainless-steel barrel bolts. The researchers encoded programs in the components to carry out the intended function. To gather the data, the researchers conducted 10 observational trials with a stopwatch to test the prototype system's efficiency in terms of its performance and the difference between the automated door and the One-Lock Standard Door in terms of convenience and response time. Based on the results and data gathered, it can be concluded that the machine is more convenient and has a 90% performance rate in terms of the LED warning, unlocking of the door, and buzzer warning signal. Findings also show that the response time is faster in the automated door than in the One-Lock Standard Door. It was tested and proven by getting the average mean and performing a T-test on the data gathered by the researchers themselves. The researchers then recommend that future researchers implement this on other types of door locks and enhance the LCD feature by displaying the type of smoke sensors.

Keywords: smoke alerts, automated door, automatic unlock of door, smoke detector, experimental study

Smart Safety System: Arduino Uno-integrated door for fire and smoke alerts

1. Introduction

Fires may occur at any time, and according to Gascon (2024), there were 10,996 fire incidents documented from January 1 to June 10, with 8,182 events in 2023, representing a 34.4 percent rise in fire incidents nationwide. Fire safety remains a significant concern in residential and commercial settings, particularly in the Philippines. Among these incidents, schools are mainly involved. One factor contributing to the fire at Inarawan National High School in Barangay Inarawan, Naujan, Oriental Mindoro, is the area's fluctuating power supply, which causes significant damage (GMA Regional TV News, 2024). Research indicates that the most frequent causes of school fires nationwide are arson, electrical failures, and broken heating equipment. Cooking contributes to 64% of preschool and childcare expenses, with heating coming in second at 7% and electrical distribution at 6%. Furthermore, the leading causes of fires in kindergarten or elementary schools include cooking (27%), incendiary or suspicious activity (25%), and heating (12%) (Topical Fire Research Series, n.d.).

Traditional smoke detection is effective but often lacks real-time communication and responsiveness, leading to delayed reaction during critical situations. According to the study of Shoji et al. (2020), children's responses to disaster are poorly understood, and factors such as emotion may affect responsiveness during evacuation. The concept of intelligent systems is now increasingly becoming profoundly significant with the rapid technological progress that changes safety rules. Thus, this research developed a smart safety system using Arduino Uno to improve fire and smoke alerting mechanisms. Integrating microcontroller technology into fire safety systems means much responsiveness and automation. With this aim, the project utilizes a sensor integrated with an Arduino Uno microcontroller to create an automated door that responds by opening in cases where fire or smoke is detected. Although various fire detection systems exist, most lack the alert and response system that would immediately or automatically occur during an incident.

Like Adams and Giap's (2024) study, automatic door systems typically rely on motion sensors to trigger opening, which can delay access during a fire situation when immediate evacuation is necessary. In this prototype system, doors automatically open based on smoke levels, each corresponding to a series of automated actions, facilitating a more rapid response. This design addressed the gap in existing systems that may not activate in time for distressed individuals. Studies indicate that effective smoke detection can reduce the risk of damage and death by 25% or more in residential fires (Gilbert, 2021). The existing research focuses primarily on standalone smoke detectors and does not sufficiently address integrated solutions that improve user safety and fast evacuation. This research study designed, installed, and tested an Arduino-based Smart Safety System that provides quick alerts and controlled access through the doors during fire situations without using a motion sensor. To enhance fire security and ensure speedy evacuation in case of a fire emergency, this paper introduces an emergent technology for the automatic control of doors in a situation of fire. This paper describes a system that detects various smoke levels with automated actions. This study contributed to synthesizing knowledge that will prove worthwhile in providing insights on the effectiveness of integrated door safety systems concerning upgrading the technologies involved in fire safety and providing a safer, more effective, and faster evacuation solution for protecting lives and properties. This approach bridges the gap between traditional fire safety measures and modernism, contributing to a safer environment.

Statement of the Problem - The study aimed to develop and test an Arduino-based fire safety system that automatically opens doors when smoke is detected. This system provided visual and audible signals to assist in evacuation. The study addressed the following questions: (1) What is the level of performance of the automated door activated by the smoke detector in terms of LED warning signals, automatic opening of the door, and buzzer warning signal? (2) What are the best features of an automated fire safety system for doors in terms of speed and accuracy in smoke detection? (3) Is there any significant difference between the automated door activated by

smoke detectors and the one-lock standard door in terms of convenience to participants and response time in an emergency?

Significance of the Study - The findings of this study make a substantial contribution to the development of improved gas and smoke detection. It aimed to produce a proactive and reliable method for innovative safety systems in alerting individuals of possible fire outbreaks, specifically in school settings. Apart from prevailing in the existing body of knowledge, the result of the study benefits the following: the students that stand to benefit from the study, as it would facilitate a fire safety system assisted by automated doors, and thus it will help them to have prompt evacuation during fire breakouts. For the teachers, as the fundamental providers of learning and knowledge, this study could also help expedite evacuation. Integrating such technology with automated doors that unlock when different levels detect smoke demonstrates a proactive approach to safety management. Moreover, it provides an opportunity to educate students about fire safety protocols, the importance of quick response during emergencies, and attaining peace of mind knowing that a reliable system protects the student during possible fire outbreaks. The parents may use the result of this study to have a sense of knowing that their child will be safe during fire alerts. A sense of security can contribute to a more positive learning environment, as they will feel at ease with the school's safety measures.

Additionally, it might make them participate more in school safety measures that will create an approach to ensuring their child's safety. The school administrators will obtain insights from the study that would enhance the overall safety protocols within the school. This proactive approach minimizes potential risks and demonstrates the institution's dedication to maintaining high safety standards. The local government unit is responsible for attaining school safety through innovative and cost-effective improvements in fire regulations and, with such a system, enhancing standards to improve safety and rectify the defects in existing fire prevention mechanisms in the community. This will be particularly efficient for rural or poorly funded schools that do not enjoy access to sophisticated technologies regarding safety. LGUs would be able to improve safe learning environments for children and their educators.

The Bureau of Fire Protection is a primary authority in ensuring the effectiveness of fire safety measures, as its expertise assists in developing more advanced fire detection systems. They are essential in enhancing public awareness and immediate response planning, providing students and school personnel with a secure environment. The researchers acquired insights from the study into the effectiveness of automated safety solutions. Their experiences provided valuable hands-on learning in designing and implementing advanced safety systems. Furthermore, they better understood the connection between technology, safety protocols, and human behavior in emergencies for the future researchers who may explore a similar topic. The findings and methodologies from this study can serve as a foundation for future research in automated safety systems, not only in educational settings but also in other public spaces. Future researchers may build upon this work to develop more technically savvy automated doors and smoke alerts.

Scope and Delimitation of the Study - The study developed and evaluated the use of automated doors for smoke and fire alerts. The system also provided audio and visual alerts. The focus was on creating a prototype of an innovative safety system using Arduino Uno to integrate doors for smoke and fire alerts. The study was performed in the academic year 2024-2025. This academic year covers the process of the study's production and examines the safety and security measures for classroom exit doors. The study is limited to grade school and pre-school classrooms, specifically grade levels from grade 2 and lower levels, and focuses only on exit doors equipped with stainless steel barrel bolts. It may not apply to other departments or doors with different locking systems. The researcher observed and served as a respondent for this research. Upon doing the observation, the researchers are guided by their adviser to ensure that accurate data is gathered.

2. Methodology

Research Design - The researchers conducted an experimental study to develop an integrated door for smoke

and fire alerts that is convenient to use in smoke and fire emergencies. This study employed applied research to address its objectives. This research design provided a clear and effective way to develop an integrated door for smoke and fire alerts to facilitate safe evacuation and improve emergency response. The researchers also collected data on the integrated door's performance and effectiveness for smoke and fire alerts.

Data Gathering Procedure - In this experimental study, data gathering was done by constructing and testing Arduino Uno-integrated doors with fire and smoke alerts. It starts by obtaining all documents for procuring materials like microcontrollers, sensors, and mechanical devices. The first assembly stage was described step-by-step, photographed, or filmed to provide transparency and traceability on the work performed by the researchers. After assembling the device, testing was conducted for smoke detection, door opening, and alert mechanisms before the performance of the device could be determined. Performance data was also recorded, and the system was tested in many controlled circumstances to see how effectively it works. This allows the researchers to determine whether their proposed safety system was safe, reliable, purposeful, and practical and the benefits it could provide through this complete testing and this document. After assembling, testing, and evaluating the system's performance, the researchers took six days to complete the data-gathering procedures.

Research Process: Stage 1 Preparation and Gathering of Materials - The required components for building the Arduino Uno-Integrated Doors with Fire and Smoke Alerts are as follows: 9V batteries, an Arduino Uno microcontroller with USB cable (A to B male cable), Arduino wires, a polywood board, LED lights, a liquid crystal display (LCD), an MQ135 Gas Sensor, a servo motor, a solderless PCB breadboard, a resistor, a stainless steel barrel, a buzzer, and door hinges. The major components needed to assemble the product were purchased online, primarily from SAMIORE.ph. The materials used for prototype housing are purchased in City Hardware with a total cost of ₱1,224.

Stage 2: Building and Development of the Project - The researchers begin by developing a prototype of an integrated door system for fire and smoke alerts, with Arduino Uno serving as the central component. In the initial phase, they installed a door with a spring lock and a servo motor to allow for automatic opening when triggered by the system. They then connect a smoke sensor to the Arduino Uno via wires on a breadboard, creating the circuit connections required to detect smoke levels. A buzzer is also connected to the Arduino Uno using the breadboard, allowing it to send a warning in response to smoke detection. LED lights were also installed, as well as an LCD module to display essential alerts, both of which were programmed according to various smoke levels. The Arduino Uno is then programmed to control the servo motor for automatic door opening, activate the buzzer when smoke is detected, and interpret the sensor's indications of smoke levels. The researchers then set up specific commands in Arduino Uno to control the LED lights and LCD module. The LED lights were programmed to indicate various smoke levels, including blinking lights for low smoke, an unlocked door for moderate smoke, and an alarm with automatic door opening for high smoke levels. Finally, the researchers added a rechargeable battery backup to ensure the system remains operational during power outages, increasing its fire and smoke alarm system reliability. This step-by-step process illustrates the construction and development stages of the prototype, ensuring that the system is effectively assembled and ready for testing.

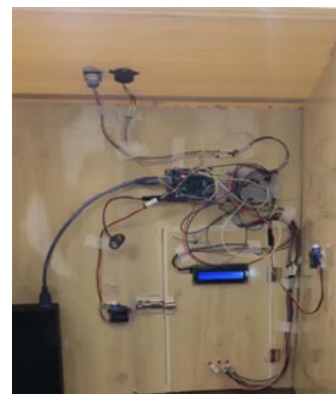


Figure 1: Actual Product of Arduino-Uno Smart Safety System

Stage 3: Experimental Stage, Observation, and Data Recording - The researchers conducted a series of tests to observe the reaction time of the smoke detector and the automated opening of doors if it responds quickly enough in times of emergency. They first activate the system to ensure that the Arduino Uno controls the servo motor correctly and that the door opens when smoke is detected according to plan. They then test the smoke sensor's accuracy and overall responsiveness by introducing various smoke levels in a controlled setting. The testing begins with low smoke levels, and the researchers ensure that the LED lights blink correctly without unlocking the door. As the smoke level rises to moderate, they check to see if the door unlocks and prepare for opening, which indicates a higher alert. When high levels of smoke are detected, the system ultimately activates, causing the buzzer and servo motor to open the door automatically while the LCD module displays an alert. During these experiments, the researchers recorded each result to assess the system's consistency and speed of response. They also evaluated the battery backup by disconnecting the primary power source and ensuring the system continued functioning during power outages. All results are carefully recorded to assess the device's dependability and ensure it meets practical safety standards.

Statistical Treatment of the Data - The researchers employed descriptive comparative design statistics using weighted means to determine the performance and benefits of the automated doors. This includes the calculation of percentage accuracy relating to the computerized door's LED warning signals, automatic unlocking of the door, buzzer warning signal, convenience to the participants, and response in emergencies. A weighted mean is applied when the different data points vary in importance, reliability, or frequency. Furthermore, to answer the inferential questions, the researchers used a paired two-sample T-test for Means to assess whether automated doors activated by smoke detectors vary from the One-Lock Standard Door. A t-test is a statistical procedure determining the difference between two groups' means. This kind of procedure would help make an inference about the population parameter based on the data of the samples. It is applied to compare two independent groups or two related groups or to establish whether the means of a single group differ from a known value. To determine the descriptive interpretation, a performance rating scale is presented: 1–5 very high performance, 6–10 high performance, 11–15 moderate performance, 16–20 low performance, & 21–25 very low performance.

3. Results and Discussions

Table 1

Mean Level of Performance of the Automated Door Activated by the Smoke Detector in Terms of LED Warning Signals

Number of Trials	Smoke Level (ppm)	LED Activation Time (Seconds)	Descriptive Interpretation
1	40	3.69	Very High
2	39	4.47	Very High
3	40	5.11	Very High
4	40	4.55	Very High
5	41	5.02	Very High
6	40	5.68	Very High
7	40	4.07	Very High
8	40	4.65	Very High
9	40	2.69	Very High
10	40	4.70	Very High
Average	40	4.46	Very High

Legend: 1–5 Very High, 6–10 High, 11–15 Moderate, 16–20 Low, 21–25 Very Low

Table 1 presents the recorded activation times across 10 trials and the computed average and descriptive interpretation. After conducting the trials, the researchers spent six days formally analyzing and documenting the results. The LED warning signal constantly activates within 4.463 seconds when smoke levels reach 40 ppm,

which is coded in the system. The very high performance rate is 100%, and there was a trial of 10 out of 10 successes. This data suggests that the LED warning signal reliably functions as an early warning indicator, although sensor sensitivity varies with a minimal second delay at first. These results confirm that the system provides a prompt visual alert, helping children be aware of smoke presence early on. These results resonated with the study of Chen et al. (2018), in which LED pointers can minimize casualties and enhance overall fire safety by immediately showing the safe exit points to building occupants. Regarding this research, approaches would agree that the quicker and more effective the response, the fewer casualties and the more efficient the evacuation. The LED activation time in seconds proves that there is an early warning signal once detected, at least minimal smoke.

Table 2

Mean Level of Performance of the Automated Door Activated by the Smoke Detector in Terms of Automatic Unlock of the Door

Number of Trials	Smoke Level (ppm)	Time of door unlocking (Seconds)	Data Interpretation
1	60	.89	Very High
2	63	1.59	Very High
3	62	1.98	Very High
4	60	2.17	Very High
5	62	2.17	Very High
6	60	1.16	Very High
7	60	0.95	Very High
8	61	0.91	Very High
9	60	2.69	Very High
10	60	2.27	Very High
Average	60.8	1.76	Very High

Legend: 1–5 Very High, 6–10 High, 11–15 Moderate, 16–20 Low, 21–25 Very Low

Table 2 indicates that the data obtained shows that the door is consistently unlocked within 1.76 seconds once smoke reaches 60 ppm, which is coded in the system. The activation time may be delayed or detected early, depending on the distance of the smoke and the speed at which the smoke reaches the sensor. The 100% very high-performance rate indicates a reliable response, but factors may affect occasional failures and suggest further refinements for precise accuracy. To enhance the precision and reliability of the data collection, the researchers implemented a six-day trial period. These findings confirm that the system responds quickly to smoke, improving fast and efficient access during emergencies. This corresponds to the study of Mathavan et al. (2020) where automated door unlocking is advantageous in emergency scenarios when, for example, babies or individuals who inhale hazardous gasses from a fire and become unconscious and confined within the vehicle, in this case, the classroom, are affected. A person outside can save their lives in such a situation by opening the door from the outside. Opening the doors will not be difficult because this system has a separate mechanism for unlocking each.

Table 3

Mean Level of Performance of the Automated Door Activated by the Smoke Detector in Terms of Buzzer Warning Signal

Number of Trials	Smoke Level (ppm)	Buzzer Activation Time (Seconds)	Data Interpretation	Door opening Delay (seconds)	Data Interpretation
1	80	1.30	Very High	5.59	Very High
2	79	11.26	Moderate	5.14	Very High
3	80	4.80	Very High	6.89	High

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4	81	8.21	High	5.31	Very High
5	82	4.10	Very High	5.37	Very High
6	80	4.76	Very High	5.30	Very High
7	80	6.87	High	5.30	Very High
8	80	8.60	High	4.92	Very High
9	80	7.83	High	5.10	Very High
10	80	5.43	Very High	5.37	Very High
Average	80.375	6.316	High	5.43	Very High

Legend: 1–5 Very High, 6–10 High, 11–15 Moderate, 16–20 Low, 21–25 Very Low

Table 3 illustrates the data acquired from the buzzer that is activated within an average of 6.316 seconds when smoke reaches 80 ppm, which is coded in the system, followed by a 5.429-second delay before the door opens, resulting in an average total time of 5.429 seconds. The combined success rate of 90% suggests that most trials achieved a timely activation of the buzzer warning signal and an accurate second delay before opening the door. However, the opening of the door and audible warning may not occur once the level of smoke reduces to ppm. These results highlight the system's reliability in responding to higher smoke levels and the accuracy of 5-second intervals of opening the door once the buzzer is activated, showing a series of practical results. This situation is interrelated with the study of Takeuchi and Ishida (2022d) regarding sensors that detect incoming vehicles and alert the person who opens the door through LED lights or a buzzer when opening the door. The occupant must understand the alarm to avoid an accident and instantly stop opening the door. Concerning this, the buzzer is a signal that means the door will automatically open after five seconds because the smoke sensor has detected a high-intensity level. Upon hearing the buzzer, stay alert and immediately proceed to the exit. The data collection process was extended over six days to achieve high accuracy and reliability.

Table 4

Feature of Automated Door Activated by the Smoke Detector in Terms of Speed

Features	Response Average Time (seconds)
LED Warning Signals	4.463
Automatic Unlock of Door	1.678
Buzzer Audible Signal	6.316
Automatic Opening of the Door	5.429

The average time is obtained by getting the mean of the 10 trials of each feature. The table indicates a response average time of 1.678 seconds for automatic unlocking of the door, indicating that the best feature of the smart safety system's automatic door in terms of speed is the automatic unlocking of the door. To uphold accurate precision and ensure the dependability of the gathered data, the researchers implemented a six-day trial period.

Table 5

Feature of Automated Door Activated by the Smoke Detector in Terms of Accuracy

Features	No. of trials	Number of times smoke is detected	% of Accuracy
LED Warning Signal	10	10	100
Automatic Unlock of Door	10	10	100
Buzzer Warning Signal	10	10	100
Automatic Opening of the Door	10	10	100

Table 5 illustrates the system's 100% capability in smoke detection across numerous trials for each of its main features. To ensure the accuracy and reliability of the data, the researchers carried out these trials over six days. The MQ-135 gas sensor identifies dangerous gases with a remarkable ability to detect key features. These results show that the system works well in detection, making it a reliable safety feature. As stated by Badamasi (2014), the control system based on Arduino guarantees efficient data processing to support the use of microcontrollers and improves fire safety solutions. Following the TAM principle cited by Silva (2015), the system's accuracy guarantees that users will find it a reliable and effective fire safety solution. Additionally, the automatic door response and real-time fire and smoke alarms could reduce the hazards during emergencies; therefore, the individuals should view the system as beneficial, and its perceived ease of use emphasizes how crucial the system is, especially in an emergency.

Table 6

Data on the performance of the automated door activated by the smoke detectors toward the one-lock standard door in terms of convenience to participants

	X	Y
Number of trials	Automated Door in terms of: Convenience to participants (s)	One-Lock Standard Door in terms of: Convenience to participants (s)
1	11.47	19.24
2	22.46	54.48
3	18.78	25.13
4	20.24	50.86
5	16.66	28.11
6	16.9	59.28
7	17.19	24.04
8	19.08	22.45
9	15.62	17.86
10	17.77	30.14
Mean:	17.617	33.159

Table 6 provides a comparison in terms of the convenience of automated doors and a one-lock standard door to participants. The results show that automation significantly improves evacuation time, as they open automatically when triggered, allowing participants to leave the room without any manual effort. This feature is particularly useful in emergencies that require quick action; the less time it takes, the more convenient it will be. In contrast, a one-lock standard door requires participants to unlock and open it manually before exiting, which can cause delays and make evacuation more difficult, especially in high-stress situations. The findings emphasize that automated doors enhance safety by minimizing human intervention and reducing the risk of delayed evacuations. According to Gaulton (2024), automatic doors have become common in public spaces, including educational institutions. These doors improve convenience, accessibility, and safety for students, staff, and visitors. Additionally, automated doors can be connected to emergency response plans, facilitating a safe and quick evacuation in an emergency. Reducing delays during emergencies is essential; these doors can quicken evacuation, protecting all the individuals inside the school premises.

This analysis enables researchers to determine whether a significant difference exists between an automated and a one-lock standard door. The $| -3.48 | = 3.48 > 2.26$ result indicates that $t_{\text{comp}} > t_{\text{crit}}$, and the p-value (0.04) is less than the alpha level 0.05. Therefore, the null hypothesis is rejected, supporting the alternative hypothesis. This confirms that the data are significant and indicates that automated doors are more convenient for participants than a one-lock standard door. These findings highlight the statistical significance of automated doors in providing quicker and more efficient access during fire situations. According to Abdulsahib & Khalaf (2018), experts suggest immediate fire detection and monitoring can save lives and prevent death and collateral

damage in premises fires. This study supports that an automatic door actuated by smoke detectors is more efficient and improves evacuation time for participants than a one-lock standard door.

Table 7

T-test results: Paired Two Sample for Means

t-Test: Paired Two-Sample for Means		
	Variable 1 Automated Door in terms of: Convenience to participants (s)	Variable 2 One-Lock Standard Door in terms of: Convenience to participants (s)
Mean	17.617	33.159
Variance	8.58189	241.6583878
Observations	10	10
Pearson Correlation	0.561972131	
df	9	
t Stat	-3.483528322	
P(T<=t) one-tail	0.003450052	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.006900104	
t Critical two-tail	2.262157163	

Legend: p-value ≤ 0.05 significant

Table 8

Data on the performance of an automated door activated by the smoke detectors toward the one-lock standard door in terms of response time in an emergency

	X Automated Door in Response Time (s)	Y One-lock Standard Door in terms of: Response Time (s)
Number of trials		
1	11.47	12.12
2	22.46	47.91
3	18.78	20.59
4	20.24	44.7
5	16.66	20.11
6	16.9	51.27
7	17.19	23.01
8	19.08	21.78
9	15.62	16.88
10	17.77	16.86
Mean	17.617	27.523

Legend: p-value ≤ 0.05 significant

Table 8 shows the response time for the automated and one-lock standard door. The results show that the proposed product has the accurate function and has the feature to sense the smoke, resulting in a more efficient escape from the room. At the same time, response time in a one-lock standard door requires the sense of smell to react to the smoke before escaping the room. These findings emphasize the benefits of automated doors in improving safety and efficiency during emergency evacuations. The recorded response times demonstrate that the automated door reduces the delay in detecting smoke and initiating an escape.

Table 9*T-test results: Paired Two Sample for Means*

t-Test: Paired Two-Sample for Means	Variable 1	Variable 2
	Automated Door in Response Time (s)	One-lock Standard Door in terms of Response Time (s)
Mean	17.617	27.523
Variance	8.58189	210.5769789
Observations	10	10
Pearson Correlation	0.610629822	
df	9	
t Stat	-2.422284183	
P(T<=t) one-tail	0.019233132	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.038466264	
t Critical two-tail	2.262157163	

Legend: p-value ≤ 0.05 significant

Table 9 shows the data using the t-test: Paired Two Sample for Means. Allows the researchers to determine a significant difference between the automated and a one-lock standard door in terms of response time. The researchers collected the data over six days to ensure accurate and reliable results. The $|-2.42| = 2.42 > 2.26$ result indicates that $t_{\text{comp}} > t_{\text{crit}}$, and the p-value (0.04) is less than the alpha level 0.05. Therefore, the null hypothesis is rejected, supporting the alternative hypothesis. This confirms that the data are significant. The findings suggest that the automated door allows a faster exit than the one-lock standard door. Its more rapid response time emphasizes its usefulness in emergencies, as it reduces the delay associated with manually unlocking and opening a traditional door. According to Fang et al. (2021), incorporating automation into emergency preparation enhances effectiveness by increasing speed, lowering human error, adapting to real-time situations, and optimizing evacuation routes for more safety. The study found that automated doors are a more efficient, convenient, and potentially life-saving solution in emergencies.

4. Conclusions

Based on the summary of the findings, the following conclusions were drawn relating to the research problem stated: The level of performance of the automated doors activated by smoke detection has a more than 90% success rate in terms of the LED warning signal, unlock of the door, and buzzer activation. The best feature of the Smart Safety System Automatic Door is the automatic unlocking that activates in 1.678 seconds, while the system can detect smoke with 100% accuracy. There is a significant difference between the automated door activated by smoke detectors and the one-lock standard doors in terms of convenience to the participants, with an average exit time of 17.617 seconds and a response in an emergency time that responds with the same average of 17.617 seconds.

4.1 Recommendations

The recommendations below serve as a valuable resource for future researchers aiming to enhance and optimize the efficiency of the product. The researcher recommends that future coders of the group improve the feature of the LCD showing the type of smoke detected by the sensor. The researchers recommend that the school technicians and electrical engineers install LED strip lights that improve the door's functionality, resulting in a brighter way out when the smoke rapidly disperses. Moreover, the researchers recommend that future researchers implement this to other types of door locks to guarantee that exit ways can be safe, convenient, and promptly unlocked during fire emergencies.

5. References

- Abdulsahib, G. M. & Khalaf, O. I. (2018). An Improved Algorithm to Fire Detection in Forests by Using Wireless Sensor Networks. *International Journal of Civil Engineering & Technology (IJCIET) - Scopus Indexed*, 9(11), 369-377.
https://www.researchgate.net/publication/329733243_An_improved_algorithm_to_fire_detection_in_forest_by_using_wireless_sensor_networks
- Adams, D., & Giap, Y. C. (2024). Prototype of an automatic door and fire alarm system based on IoT. *bit-Tech*, 6(3), 363–370. <https://doi.org/10.32877/bt.v6i3.1246>
- Badamasi, Y. A. (2014). The working principle of an Arduino. *11th International Conference on Electronics, Computer and Computation (ICECCO)*. <https://doi.org/10.1109/icecco.2014.699757>
- Chen, X.-S., Liu, C.-C., & Wu, I-Chen. (2018). A BIM-based Visualization and Warning System for Fire Rescue. *Advanced Engineering Informatics*, 37, 42–53. <https://doi.org/10.1016/j.aei.2018.04.015>
- Fang H., Lo, S. & Lo, J.T.Y. (2021). Building Fire Evacuation: An IoT-Aided Perspective in the 5G Era. *Buildings*, 11(12), 643; <https://doi.org/10.3390/buildings11120643>
- Gascon, M.(2024, June 11). *BFP reports a 34.4 percent hike in fires nationwide*. INQUIRER.net.<https://newsinfo.inquirer.net/1950266/bfp-reports-34-4-percent-hike-in-fires-nationwide#ixzz8oElIoKhb>
- Gaulton, J. (2024, July 22). Implementing automatic doors in schools and Educational Spaces. ADC Entrance Solutions. <https://adcentrances.com/implementing-automatic-doors-in-schools/>
- Gilbert, S. W. (2021). Estimating smoke alarm effectiveness in homes. *Fire Technology*, 57(3), 1497–1516. <https://doi.org/10.1007/s10694-020-01072-z>
- GMA Regional TV News. (2024, March 21). Fire hits 5 classrooms in a school in Oriental Mindoro. *Fire Hits 5Classrooms in School in Oriental Mindoro*.<https://www.gmanetwork.com/regionaltv/news/101034/fire-hits-5-classrooms-in-school-in-oriental-mindoro/story/>
- Mathavan, J. J., Faslan, A., Basith, N. U. A., & Wanigasinghe, W. (2020). Hardware implementation of fire detection, control, and automatic door unlocking system for automobiles. *2022 6th International Conference on Trends in Electronics and Informatics (ICOEI)*, 125–129. <https://doi.org/10.1109/icoei48184.2020.9142990>
- Silva, P. (2015). Davis' Technology Acceptance Model (TAM) (1989). In *Advances in knowledge acquisition, transfer, and management book series/Advances in knowledge acquisition, transfer and management book series* (pp. 205–219). <https://doi.org/10.4018/978-1-4666-8156-9.ch013>
- Shoji, M., Takafuji, Y., & Harada, T. (2020). Behavioral impact of disaster education: Evidence from a dance-based program in Indonesia. *International Journal of Disaster Risk Reduction*, 45, 101489. <https://doi.org/10.1016/j.ijdrr.2020.101489>
- Takeuchi, K., & Ishida, M. (2022d). Development of Automatic Door Lock System to Help Prevent Collisions between Opened Doors and Approaching Vehicles When Exiting Vehicle. *SAE Technical Papers on CD-ROM/SAE Technical Paper Series*. <https://doi.org/10.4271/2022-01-0068>
- Topical fire research series. (n.d.). In *National Fire Data Center* (pp. 1–4). <https://files.eric.ed.gov/fulltext/ED498391.pdf>

