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A Systematic Review On The Effectiveness Of Using Smart Prevention System To Overcome Fire Disaster

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Abstract: Automatic fire prevention systems are installed in large capacity buildings and residential areas where fire risk is high. So this paper discusses the effectiveness and capabilities of the fire prevention system in extinguishing fires in a short time at an early stage. However, there are some complaints from users that the system is not working correctly, the installation cost is too expensive, and the system design is not relevant nowadays. Therefore, from the complaints identified, we have conducted a study to issue a systematic survey to assess the public's understanding of the cost of installing this system in residential and building areas. A study was also conducted to identify the current work system to be used as a reference so that new upgraded systems can be released and examine the use of Arduino UNO in the current system. The previous studies through the Google Scholar platform, Science Direct, and official websites have related to the study were fine and shortlisted a total of 30 articles journals as references. Overall, this systematic review found some information to support where there are some shortcomings of the existing fire prevention system. This system needs to be upgraded to be more effective in dealing with fires in the future.

Keywords: effectiveness, fire prevention system, residential buildings

1. Introduction

Nowadays, fires are one of the most popular disasters in the world that can cause large-scale damage and where fires can cause loss of property and severe lives. Fires can be categorized into four main categories, namely Class A, which involves flammable solid materials, for example, wood, clothing, paper, and plastic. While the Class B involves liquid materials; for example, oil, tars, and non-

combustible gases. Also, Class C involves flammable gases such as methane and hydrogen gas. Class D involves flammable metals and finally, a Class K where the fire involves flammable materials such as fuel usually found in the kitchens residential homes [1].

As an initiative, fire prevention systems have been widely used in critical areas such as employment buildings, residences, hospitals, and so on as a new fire prevention medium. Without this system, many precious lives and property are at high risk in an emergency or unexpected fire [2]. This system is used to provide the most reliable method of automatically detecting and extinguishing fire in the early stages. The examples of the current fire prevention systems such as pressure sprinkler systems, fire alarm systems, building fire hoses and fire extinguishers. Another example of a fire prevention system is a pressure shower system where are widely used worldwide, with more than 40 million system heads installed each year. In buildings today, it is fully protected by this system, and more than 96% of fires are successfully controlled by fire prevention system [3]. However, the existing system still has many weaknesses that need to be upgraded becomes more effective in helping to deal with fires at an early stage.

The production of a fire prevention system that has been upgraded its called "Smart Fire Prevention System". It provided the effectively fire prevention because the majority of the system has been upgraded in terms of quality. The "Smart Fire Prevention System" is produced to measure the level of effectiveness in extinguishing fires from a small until a large scale at the early stages. It can be used to prevent any accidents involving lives in commercial or residential buildings. Therefore, this study is significant to reduce the annual fire cases in Malaysia and also to measure the effectiveness of this upgraded system in dealing with fires at an early stage. The system will be replaced with existing systems in the market. This systems are equipped with modern electronic components and refurbished components on every existing fire prevention system.

2. Methodology

The PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses. It is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses [42]. The PRISMA guideline has been followed to complete this systematic review of paper studies and it consist of three phases of processes. The first phase is searching from the related of articles by keywords andfounded 67,546 articles match. In the second phase, the result of each keyword's finding was filtered to enter the selection and exclusion phase to select articles that meet the criteria of these studies.

Finally there is the eligibility process where the articles was meet the criteria will be used and examined to obtain of the article's findings. The total of 67,546 articles only 30 articles was selected as a citation of references. Table 1 shows the keywords that have been used, and Table 2 shows the eligibility and exclusion process.

Table 1: The keyword from Google Scholar searching views

Database	Keyword	Result, n =
Google Scholar	1. Fire Prevention System Using Arduino 2. Arduino sensor fire safety 3. Smart Fire alarm system 4. Smart Fire Detection System 5. "Sistem Pencegah Kebakaran Arduino" 6. Smart Fire Prevention System	1. 3300 2. 5410 3. 19000 4. 20,800 5. 336 6. 18700 n = 67545

Table 2: The keyword of used for the eligibility and exclusion process

Criterion	Eligibility	Exclusion
Literature type	Indexed Journal (research articles)	Non indexed journals, Systematic review journals, chapter in book, conference proceeding
Language	English, Bahasa Malaysia	Non-english will be rejected (except Bahasa Malaysia)
Timeline	2015 - 2020	<2015

3. Results and Analysis

Figure 1 shows the flow chart for the systematic review how the evaluation of the selection of appropriate articles. The total of 67,546 articles found and screened according to the article's suitability. The results of this systematic study have identified several articles are related to the project study. The keyword of "the effectiveness of smart fire prevention system in overcoming fire". Through segregation, qualification, filtering and selection that meet the set criteria are 67,546 according to each keyword used. After going through the selection process, only 30 articles were used as data for this year's end project.

The articles used are mostly related to the "smart fire prevention system," a fire prevention system in buildings whose function is different from the existing system. This system can give a fast response and give an early warning sign of a fire outbreak [4]. This system uses various types of sensors, monitors, electronic devices, as well as the IoT method, which is the "internet of things" in this fire prevention system. IoT is a system that is interrelated with computing devices, mechanical, objects, digital machines, or people provided with unique identifiers [5]. This smart fire prevention system helps in detecting and extinguishing fires that occur in buildings faster. The systems are built using electronic devices from the Arduino Uno and Raspberry Pi where are two different types of boards. The Arduino Uno is a microcontroller, which is a part of the computer. It runs only one repetitive program, and Raspberry Pi is a mini-computer with Raspbian OS. It can run multiple programs at a time [6]. To build this system where one needs to have electrical related skills and coding where for this system works according to logic and settings through coding to work well and thoroughly.

Several types of Smart Sprinklers have a variety of unique shapes and methods in extinguishing fires. Among them, "automatic Robot fire extinguisher," can move automatically and manually to extinguish the fire. Smart sprinklers can also move and extinguish the fire from several angles; it is very different from the existing fire prevention system that only extinguishes fires within its area. It is shown that this new fire prevention system is more effective in extinguishing fires and minimizing damage to buildings due to fire. There are also Smart sprinkler systems using the GSM model, which is an electronic device that can generate communication lines via smartphone or computer [7]. This type of smart sprinkler system helps give early warning to homeowners in the event of a fire and helps prevent loss of life. Table 3 highlighted the summary and effectiveness of each of the 30 articles that refer to the effectiveness of this Smart fire prevention system. All the articles used are articles that have been published from 2015 to 2020. The summary results from all these articles show different ways and effectiveness in detecting and extinguishing fires.
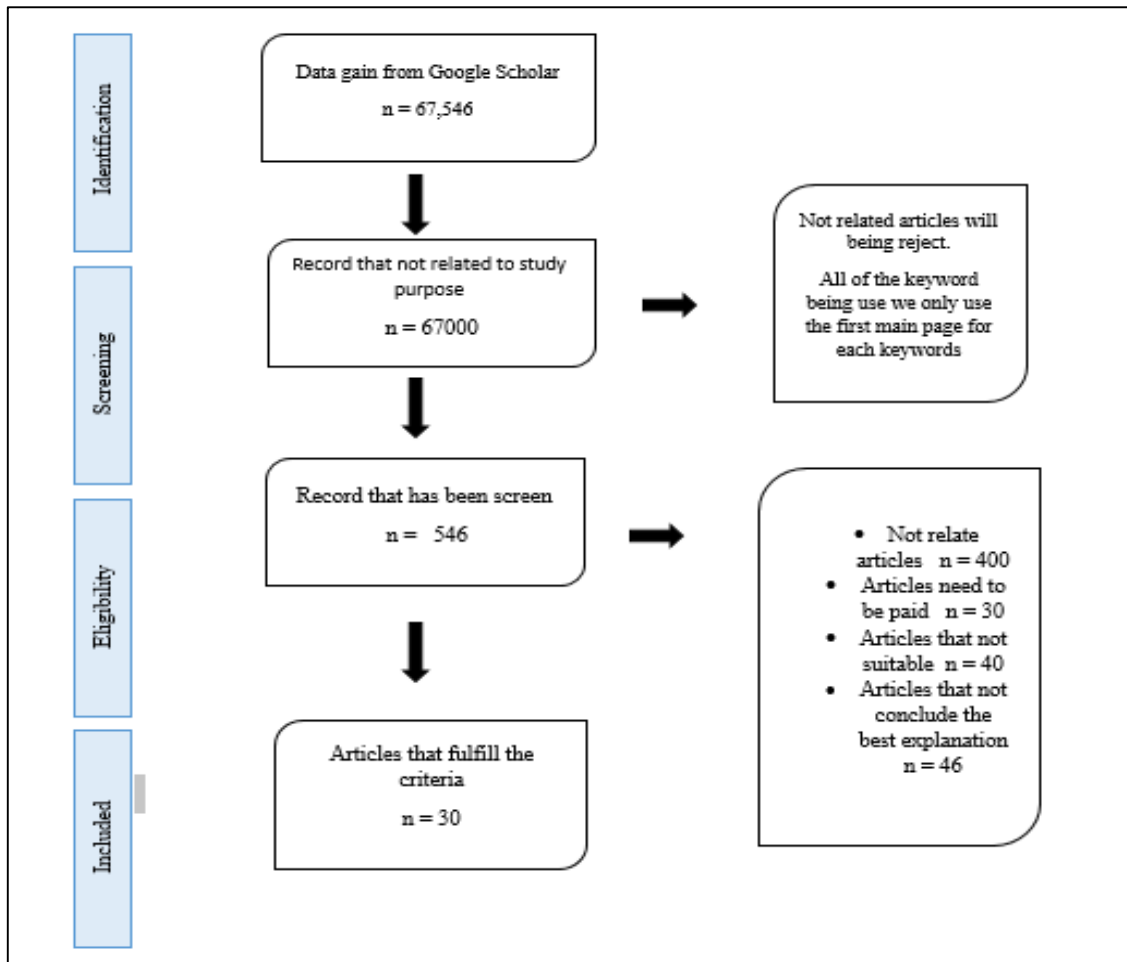
Figure 1: PRISMA Flowchart for the systematic review of the effectiveness of Smart Fire   Prevention system to overcome fire disaster.

4.   Conclusion

Based on Table 3, 30 articles used about the "smart fire prevention system," results show that each of the following systems brings different results; each of the following systems shows differences in mechanisms in detecting and extinguishing fires. Although not all of these systems work to extinguish the fire directly, some systems give early warning to home users to save themselves in the event of a fire. Among the systems in question is the "Home-based fire monitoring and warning system" [8]. The Arduino-based system gives early warning to homeowners, and also it can continue to provide information to fire fighters when a fire outbreak happens. Also, a smart sprinkler system involves "IoT" which is the "internet of things." The internet of things refers to a system of computing devices that have to do with mechanical and digital machines. It can transfer data without the need for help and interaction from humans [9].

The production of this smart fire prevention system is not an easy task to perform, where the operation of this smart sprinkler system depends on the coding of the system itself. The system code that is built must be done carefully to avoid error. Based on the articles that have been studied, all these systems require coding for their respective systems. For systems that use the Arduino Uno microcontroller, the following system language cards are the same as the C ++ language code, and the system also uses "Fuzzy logic." Fuzzy logic is a method of computing based on "true" or "false" this system is standard in today's computers [10]. The invention of this system has given a positive marker, and it shows that the technology related to this fire prevention system is becoming more sophisticated.

The data results show that the system works well and effective in detecting fire, warning alarm, and extinguishing fires. Table 3 below will give a brief description of the fire prevention system that we have studied based on the 30 articles that have been used.

Table 3: Summary of article

Article	Author	Summary
A Mobile-Sensor Fire Prevention System Based on the Internet of Things	[11]	This system provides warnings and locates where fires occur in buildings. It is equipped with a temperature sensor, a fire detector sensor, a smoke detector sensor. When a fire occurs, it will send signals and warnings to the building occupants via their phones. This system can also detect when there is a change in temperature in the building. It will collect every finding of temperature change data from anticipating the presence of fire that will occur.
Fire alarm systems based on internet of things technologies	[12]	Implement a prototype system by accessing an open-source computing platform based on Arduino technology using a personal computer that provides communication and user interface for both control and fire systems alarm system.
Home based fire monitoring and warning system	[13]	Produce a system of fire monitoring and alarm based on the Arduino system for homeowners, especially for controlling from the cause of the fire to avoid the loss of property and loss of life due to fire incidents.
Implementation of controlled robot for fire detection and extinguish to closed areas based on Arduino	[14]	The project's initial stage was to find the portion of the fire derived from the ignition sensor and wireless camera. Fire and wireless camera sensors can detect fire at certain distances. API and wireless camera sensors are not able to accept or detect data when outside the specified area.
Wireless fire detection monitoring system for fire and rescue application	[15]	Fire alarm Monitoring System detection using Microcontroller Arduino is a design to ensure this method can be carried out correctly. This system includes a buzzer, smoke sensor, and a camera. The data taken from the smoke sensor and camera will be sent to the data monitoring system and be display on the monitoring system wirelessly.
A Low-cost R-type fire alarm system for old houses	[16]	The system would be monitoring the building if the fire outbreak happened. This system would alarm the resident in the building. If the system does not detect or sense any fire, it will reboot its system to monitoring mode. These systems use an Arduino Uno microcontroller.
Fire safety and alert system using Arduino sensors with IoT integration	[17]	Integrating IoT into the fire safety system significantly increases effectiveness and efficiency. With the use of sensors, fire hints such as temperature rise, the presence of fire, gas, and smoke are detected effectively.
Quick fire sensing model and extinguishing by using an Arduino based fire	[18]	The system can detect a fire by capturing images of smoke generated at the beginning of the fire.
Sistem kebakaran menggunakan sensor infra red dan sensor suhu berbasis Arduino UNO	[19]	This system detects fire using a temperature sensor and using an infrared sensor and Arduino Uno as its microcontroller. This system can detect a particular type of temperature and come out with a different signal to show information about the room's different temperatures. This system also has an alarm that can give a warning whenever a fire breakout happens.
Smart home automation and security system using Arduino and IoT	[20]	The design provides simple and cheaper detection, monitoring, and control methods in the domestic field and industry standards to implement IoT.

Smart fire safety system in a building	[21]	This technique is used to make positive decisions because it allows the smoke to be removed from the building. Therefore, there is not much possible loss of human life caused by respiratory problems.
Vision based automatic fire protection system using sprinkler	[22]	Use control systems and mobilizers and digital imaging to propose new solutions for old problems. The prototype system is installed, showing the proposed alternative appropriateness successfully to replace conventional fire draining.
An Automated Fire Suppression Mechanism Controlled using an Arduino	[23]	The system managed to extinguish the fire appropriately even though some difficulties occurred due to the system's loss of water. However, it still achieved a set objective whereby the system could extinguish the fire in a short time.
Wireless sensor network on LPG gas leak detection and automatic gas regulator system using Arduino	[24]	Sensor calibrations require a lot of effort as it is challenging to get the value of 1000 ppm and Ro value accurately. The sensor calibration still needs a comparison tool. So, in this simulated, MQ-6 will be fixed at a value of 300. The buzzer will remain active when the sensor reaches the lowest limit of 300 based on the value given by MQ-6.
Disaster detection system using arduino	[25]	This disaster detection system works well and has successfully detected the increase in water level, fire, gas leakage, and earthquake based on condition conditions.
Towards Reducing the damage of fire through firefighting autonomous robot	[26]	The Robot being placed in a room. Then the robot will detect the presence of fire that is present in the chamber. The Robot can detect fire that has waves from 760mm to 1100mm in a distance of 20cm from three different directions.
Water mist fire suppression system	[27]	Define and extend the expression of water fog with precise details of the model throughout the year since the 20th century—application and system testing protocols. Fluid and pressure systems are protected and provide useful information for future studies.
Intelligent Fire Detection and Visual Guided Evacuation System Using Arduino and GSM	[28]	The proposed project is a cheap, smart, and easy to install fire response system in the area car park. With the increase in size and complexity of buildings and other infrastructures, the system's fast response is the need for time to avoid or reduce life loss and human possessions due to accidental fire.
Development and Implementation of Arduino Microcontroller Based Dual Mode Fire Extinguishing Robot	[29]	This robot Model will be tested by using proteus simulation to be tested and studied. This project will be able to create new methods in addressing fire in the building.
Smart home automation and security system using Arduino and IoT Application of Servo-Motor Control System at Smart Sprinkler	[30]	This system has created a smart sprinkler that can move into a certain angle. This smart sprinkler can extinguish the fire in some different angle and area—the movement of the smart sprinkler being supported by servo motor.
Raspberry pi based smart fire management system employing sensor based automatic water sprinkler	[31]	The proposed fire management system has advantages of early detection. This system can detect the presence of fire very well compared to the current fire prevention system. When it detects a fire, the system will continue to activate the sprinkler to extinguish the fire at a fast rate.

Design of a smart fire detection system	[32]	It can consider the computation of autonomy and secure authentication of the node location, which will help verify the WSN node position. The system that occurs effectively detects the fire using a wireless sensor network.
BIM integrated smart monitoring technique for building fire prevention and disaster relief	[33]	This system integrates information on personal localization, on evacuation/rescue route optimization with Bluetooth-based technology, and on a mobile guidance device to create an intelligent and two-wayfarer disaster prevention system framework that displays the real-time and dynamic fire information in three dimensions (3D). Applying the BIM-based system demonstrates that it may effectively provide 3D visualization to support the assessment and planning of fire safety, provide early detection and alarm responses, direct efficient evacuation, and facilitate fire rescue and control efforts to increase overall building safety and disaster-response capabilities.
Smart Apparatus for Fire Evacuation - An IoT based fire emergency monitoring and evacuation system	[34]	This system helps people to evacuate when a fire breakout happened. This system is based on an IoT system and using other types of sensors that give a signal when the fire has been detected.
Design implementation of the mobile fire alarm system using wireless sensor networks	[35]	An application developed to determine five physical home information with digital output. The Android system planned it with Arduino hardware consisting of three sensors: a fire sensor, gas sensor, and heat sensor in the house if this sensor reading value exceeds the previous threshold level, the sensor network interface system applications on the cell phone.
An Automated Fire Fighting System	[36]	he fire fighting system helps give alarm signals to the house residents by turning off fire quickly. While preventing fire is a rather complicated thing and cannot be quickly taken, using modern electronic technologies and devices such as "Automated Fire Fighting System" is the perfect option in a warning and good fire fighting from spreading bigger.
Design of an Arduino-based home fire alarm system with GSM Module	[37]	The result of this system test works successfully where the system can detect the attendance and changes in temperatures set out in the system, and the LCD screen display displays information about the fire. GSM model provides information via SMS well. This project helps house occupants in overcoming fires that occur in their homes.
An Intelligent Fire Detection and Mitigation System Safe From Fire	[38]	Experiments have been undertaken entirely to determine the effectiveness of this system using lighters. The fire from the lighters is detected, and the system will release the warning and function properly. The results showed that the Fusion method was helpful and suitable for fire sensors to detect fire more accurately. When the fire has been detected, it will send a warning signal through the cell phone's GSM model.
An Approach To Smart Home Security System Using Arduino	[39]	This smart home security has been developed using Arduino Uno and other kinds of sensors, including a flame sensor. This system can detect fire and will send information through phone if fire breakout it is because this system contains a GSM model that connected the system with a gadget such as a phone. This system was able to help people to evacuate when a fire is detected.
Smart Fire Extinguishing System (SFES)	[40]	This system has been invented to replace the traditional water sprinkler system. This system has included some different types of sensors. This system using two different types of fire extinguish mediums, such as water and nitrogen. This system will alert all the residents when the fire outbreak happed and will cut off the electricity to prevent the fire became worst.
Design and Implementation of a Smart Fire	[41]	This fire detection system has been designed using Arduino and Xbee as the webserver of this system. This system can detect fires in various

Alarm System Based of Wi-Fi over Long Distance (WiLD)	locations, and it can continue to channel information to the fire station where the fire occurred.

This systematic study shows that this more modern and sophisticated fire prevention system gives positive results in giving early warning and overcoming fire in various ways. Although this system is still not widely used in industry, and public buildings, this study has proven the effectiveness of these systems has created a system that can replace the existing fire prevention system.

5. Conclusion

Realizing the importance of these safety issues, this study is about fire control equipment in buildings such as homes, factories, offices, and so on. The methodology is about to obtain recent articles that related in building fire prevention systems that function differently than existing systems. Based on research on this system, it is shown that fire prevention systems have a positive effect and can help solve problems encountered while waiting for security personnel to fire. Besides, the presence of fire prevention systems can protect the property from damage caused by fire. Furthermore, future researchers may focus on the life or time of the fire prevention system's process action. Its can ensure or facilitate the user to make the replacement or maintenance of the fire prevention system.

Acknowledgement

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