

Assessment of Active and Passive Fire Protection System in Selected Commercial Buildings in Barangay San Isidro, Zaragoza, Nueva Ecija, Philippines

Ronie Ver A. Rubio¹, John Hanniel DG. Esguerra², Ericka Mae B. Fajardo³, Jheremy Red DV. Marzan⁴, Bryan M. Moleno⁵, Heart Angel P. Sta Maria⁶, Kevin Lester L. Mabalay⁷, Nathaniel L. Pangilinan⁸

^{1,2,3,4,5,6}Student, Civil Engineering Department, Nueva Ecija University of Science and Technology, College of Engineering

^{7,8}Faculty, Civil Engineering Department, Nueva Ecija University of Science and Technology, College of Engineering

ABSTRACT: This study assessed the availability, physical condition, and compliance of active and passive fire protection systems in selected commercial buildings in Barangay San Isidro, Zaragoza, Nueva Ecija. The study utilized a descriptive research design through field observation and on-site inspection using a structured checklist based on the provisions of the 2019 Revised Implementing Rules and Regulations of Republic Act No. 9514 or the Fire Code of the Philippines. A total of 31 commercial buildings participated in the study. Frequency count, percentage distribution, weighted mean, and composite mean were used in analyzing the gathered data. Findings revealed that fire extinguishers and compartmentation systems had the highest availability among the assessed establishments, while automatic sprinkler systems and fire doors showed limited availability. Most installed fire protection systems were found to be in excellent physical condition. Compliance assessment results indicated that smoke detectors, compartmentation systems, and exit signages were generally highly compliant, while fire extinguishers, fire doors, and means of egress systems showed areas requiring improvement, particularly in accessibility and design-related requirements. The study concluded that although existing fire protection systems are generally well-maintained and compliant, the limited availability of advanced fire safety systems affects the overall fire safety condition of the selected commercial buildings.

KEYWORDS: Fire Protection, Active Protection, Passive Protection, Fire Compliance, Fire Hazards, Safety Standards

I. INTRODUCTION

Fire remains one of the most destructive hazards affecting commercial establishments due to its significant impact on human life, property, business operations, and economic stability. Commercial buildings are particularly vulnerable to fire incidents because of high occupant density, continuous electrical usage, combustible materials, and daily operational activities that may increase fire risks. According to fire safety organizations and previous studies, inadequate fire protection systems, poor maintenance practices, and non-compliance with fire safety regulations contribute to increased fire-related casualties and property damage. As urbanization and commercial development continue to expand, the need for effective fire prevention, detection, suppression, and evacuation systems becomes increasingly important.

Fire protection systems are essential components of building safety intended to reduce fire-related hazards, protect occupants, and minimize property damage during fire incidents. These systems are generally classified into Active Fire Protection (AFP) and Passive Fire Protection (PFP) systems, both of which must be properly installed and maintained to

ensure effective fire safety performance (NFPA). Commercial buildings are particularly vulnerable to fire incidents due to electrical equipment, combustible materials, and high occupant density. In response to these risks, Republic Act No. 9514 or the Fire Code of the Philippines establishes minimum fire safety standards involving fire detection, suppression systems, exits, and occupancy safety.

In the Philippines, fire safety is primarily governed by Republic Act No. 9514, otherwise known as the Fire Code of the Philippines of 2008, together with its 2019 Revised Implementing Rules and Regulations (IRR). The law establishes the minimum standards and requirements for fire prevention and protection in buildings and commercial establishments. Fire protection systems are generally classified into Active Fire Protection (AFP) and Passive Fire Protection (PFP) systems. AFP systems include fire extinguishers, smoke detectors, sprinkler systems, and emergency lighting systems that are intended to detect, control, or suppress fire incidents. Meanwhile, PFP systems such as fire doors, compartmentation, means of egress, and exit signages are integrated into building structures to limit fire spread and facilitate safe evacuation during emergencies. The effectiveness of fire safety management depends on the proper installation, maintenance, and compliance of both AFP and PFP systems.

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Several studies emphasized the importance of maintaining fire protection systems to ensure effectiveness during emergencies. Frank et al. (2013) stated that automatic sprinkler systems significantly reduce fire spread and property damage when properly installed and maintained, while Suryoputro et al. (2018) explained that functional fire protection systems improve overall fire safety performance. However, deficiencies in maintenance, inspection, and emergency preparedness continue to affect system reliability. Passive fire protection systems likewise play an important role in controlling fire and smoke spread and supporting safe evacuation. Buchanan and Abu (2017) highlighted the importance of compartmentation and fire-resistant construction, while Hassanain and Al-Hammad (2018) reported that blocked exits, damaged fire doors, and poorly maintained emergency systems negatively affect occupant safety. These studies suggest that effective fire protection depends on both properly maintained active and passive systems.

Studies further indicate that inadequate fire safety measures, poor evacuation design, and limited emergency systems may increase evacuation delays and fire-related risks during emergencies (Guo, 2019).

Previous studies revealed that some commercial establishments only comply with fire safety requirements during inspections or permit renewal periods, resulting in inconsistent long-term maintenance practices. Pintac et al. (2021) identified deficiencies in routine inspection, equipment maintenance, and emergency preparedness among selected establishments. These findings indicate the need for continuous monitoring and assessment of fire protection systems to ensure compliance with fire safety standards and improve overall building safety.

Several studies emphasized the importance of maintaining compliant fire protection systems to improve emergency preparedness and reduce fire-related risks. However, deficiencies in maintenance, inspection, and long-term compliance practices remain evident among some commercial establishments. Most related studies focus on highly urbanized areas and large-scale establishments, while localized assessments in smaller developing communities remain limited. This creates a gap in understanding the actual condition and compliance status of fire protection systems among commercial establishments in communities such as Barangay San Isidro, Zaragoza, Nueva Ecija.

This study aims to assess the availability, condition, and compliance of active and passive fire protection systems in selected commercial buildings in Barangay San Isidro, Zaragoza, Nueva Ecija using a structured survey checklist and field assessment based on the provisions of the 2019 Revised IRR of Republic Act No. 9514. The findings of the study are expected to provide baseline information that may contribute to improved fire safety practices, strengthened compliance monitoring, and enhanced fire safety awareness among commercial establishments in the locality.

This study aims to assess the active and passive fire protection systems in selected commercial buildings within Barangay San

Isidro, Zaragoza, Nueva Ecija. The research evaluates the availability, current condition, and compliance of these systems to identify potential safety gaps.

Specifically, the study seeks to address the following research questions:

1. What is the availability status of the Active Fire Protection (AFP) systems in the selected buildings?
2. What is the availability status of the Passive Fire Protection (PFP) systems in the selected buildings?
3. What is the current physical condition of the available fire protection systems as evaluated through a structured field observation checklist?
4. What is the compliance rate for each relevant provision from the 2019 Revised IRR of RA 9514 of each available fire protection system among the buildings.
5. Based on the findings of the study, what recommendations can be proposed to enhance fire safety compliance and resilience in the area?

II. METHODOLOGY

This study employed a quantitative descriptive-assessment research design to evaluate the availability, physical condition, and compliance of active and passive fire protection systems in selected commercial buildings in Barangay San Isidro, Zaragoza, Nueva Ecija. The study involved thirty-one (31) commercial establishments selected through purposive and convenience sampling based on operational status, accessibility, and presence of observable fire protection systems.

Data was gathered through field observation and on-site inspection using a structured observation checklist based on the provisions of the 2019 Revised Implementing Rules and Regulations (IRR) of Republic Act No. 9514 or the Fire Code of the Philippines. The checklist assessed Active Fire Protection (AFP) systems such as fire extinguishers, smoke detectors, sprinkler systems, and emergency lighting systems, as well as Passive Fire Protection (PFP) systems including fire doors, means of egress, compartmentation, and exit signages. The instrument underwent validation by the research adviser and selected engineering professionals prior to data gathering.

After securing permission from barangay officials and establishment owners or authorized representatives, the researchers conducted visual inspections and recorded observations directly in the checklist forms. The assessment was limited to observable and accessible fire protection components only. No destructive testing, live fire testing, engineering simulation, or operational activation of systems was performed. The gathered data were organized, tabulated, and analyzed using descriptive statistical tools such as frequency count, percentage distribution, weighted mean, and composite mean to determine the availability, physical condition, and compliance status of fire protection systems. Responses marked as “Not Applicable” (N/A) were excluded from the computations.

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Frequency Count and Percentage Distribution: Frequency count and percentage distribution were used to determine the availability status and compliance rates of fire protection systems. The percentage was computed using the following formula:

$$\% = \frac{f}{n} \times 100$$

where:

% = percentage.

f = frequency of yes responses.

n = total number of observed buildings excluding indicators marked as not applicable or not available.

The computed percentages were interpreted using the scale in Table I which presents the compliance rate interpretation scale used in classifying fire protection system compliance

TABLE I. COMPLIANCE RATE INTERPRETATION SCALE

Compliance Rate	Interpretation
90% – 100%	Highly Compliant
75% – 89%	Mostly Compliant
50% – 74%	Partially Compliant
Below 50%	Non-Compliant

Weighted Mean and Composite Mean: Weighted mean and composite mean were used to evaluate the physical condition of active and passive fire protection systems. Numerical values were assigned to each rating category to determine the average condition rating of each fire protection component.

Numerical Rating Scale:

5 – Fully intact with no visible defects, damage, or deterioration

4 – Minor wear with no significant defects affecting condition

3 – Noticeable wear but still serviceable and in fair condition

2 – Damaged or deteriorated condition

1 – Severely damaged or non-functional condition

N/A – Not applicable or not available

The weighted mean and composite mean formulas used in the study are expressed as follows:

$$\bar{x} = \frac{\sum x}{N}$$

Where:

$\bar{x}$ = weighted mean.

f = frequency of responses.

x = numerical rating value.

N = total number of responses.

To obtain the overall condition of each fire protection system, the composite mean was computed by averaging the weighted mean values of all indicators under each system.

$$\text{composite mean} = \frac{\sum \bar{x}}{k}$$

where:

$\bar{x}$ = weighted mean per indicator

k = number of indicators

The following interpretation scale was used in analyzing the computed weighted mean values:

Table II. Physical Condition Rating Scale

Weighted Mean Range	Interpretation
4.20 - 5.00	Excellent Condition
3.40 - 4.19	Good Condition
2.60 - 3.39	Fair Condition
1.80 - 2.59	Poor Condition
1.00 - 1.79	Very Poor Condition

Table II presents the physical condition rating scale used in interpreting weighted mean values.

Ethical standards were strictly observed by securing informed consent, maintaining confidentiality of participating establishments, and ensuring that all gathered information was used solely for academic purposes.

III. RESULT AND DISCUSSION

This section presents the findings of the study on the availability, physical condition, and compliance of active and passive fire protection systems in selected commercial buildings. The results are organized according to the specific objectives of the study and are presented through tables with corresponding interpretations.

Availability Status of Fire Protection Systems

Table III. Availability of Active Fire Protection Systems

Active Fire Protection Systems	Available	Not Available	Percentage Availability
Fire Extinguisher	31	0	100%
Smoke Detector	15	16	48.38%
Automatic Sprinkler	2	29	6.45%

This table III shows the availability status of Active Fire Protection (AFP) systems among the selected commercial buildings in Barangay San Isidro, Zaragoza, Nueva Ecija. The findings show that fire extinguishers obtained the highest availability rate at 100%, indicating that all establishments have installed fire extinguishers. Meanwhile, smoke detectors showed a 48.38% availability rate, while automatic sprinkler systems obtained the lowest availability rate at 6.45%. Overall, the results suggest that basic AFP systems are commonly present in the selected establishments, while advanced fire detection and suppression systems remain limited.

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Table IV. Availability Of Passive Fire Protection Systems

Passive Fire Protection Systems	Available	Not Available	Percentage Availability
Fire Door	10	21	31.25%
Means of Egress/Exit door	27	4	87.10%
Compartmentation	31	0	100%
Exit Signages	12	19	38.70%

Table IV shows the availability status of Passive Fire Protection (PFP) systems among the selected commercial buildings in Barangay San Isidro, Zaragoza, Nueva Ecija. The findings show that compartmentation obtained the highest availability rate at 100%, followed by means of egress or exit doors at 87.10%. In contrast, exit signages and fire doors showed lower availability rates at 38.70% and 31.25%, respectively. Overall, the results indicate that while some PFP systems are commonly present among the establishments, deficiencies in fire doors and exit signages remain evident in several buildings

Physical Conditions of Fire Protection Systems:

Table V. Composite Mean of Fire Protection Systems

Active and Passive Fire Protection Systems	Composite Mean	Verbal Interpretation
Fire Extinguisher	4.62	Excellent Condition
Smoke Detector	4.96	Excellent Condition
Sprinkler Head	5.00	Excellent Condition
Fire Door	4.62	Excellent Condition
Means of Egress/Exit Door	4.47	Excellent Condition
Compartmentation	4.76	Excellent Condition
Exit Signage	4.88	Excellent Condition
Average Composite Mean	4.46	Excellent Condition

Table V presents the summary results for the physical condition assessment across all seven fire protection categories, which achieved a final average composite mean of 4.46 (Excellent Condition). Overall, the findings show that while several shops lack specific safety systems, the tools that are actually installed are kept in great shape. The table indicates that automatic fire sprinklers (Category C, $\{\bar{x}\}=5.00$) and electronic smoke detectors (Category B, $\{\bar{x}\}=4.96$) scored the highest. However, it is important to note that many properties were marked as N/A and disregarded in the computation because they do not have these systems. Specifically, 29 establishments were disregarded for sprinklers, 22 for fire doors, 19 for exit signages, 16 for smoke detectors, and 4 for primary exit doors, meaning these high scores only represent specific, smaller sample groups. On

the other hand, primary exit doors (Category E, $\{\bar{x}\}=4.47$) scored the lowest due to constant daily wear and tear from customer foot traffic. In conclusion, the high composite mean proves that existing equipment is well-maintained, though advanced protection systems remain missing for a large portion of the commercial area.

Available Active Fire Protection Compliance Per Relevant RA 9514 Provisions:

Table Vi. Summary of Compliance Rates of Fire Protection Systems

Fire Protection System	Average Compliance Rate	Interpretation
Fire Extinguisher	77.42%	Mostly Compliant
Smoke Detector	97.33%	Highly Compliant
Automatic Sprinkler	80%	Mostly Compliant
Fire Door	84.44%	Mostly Compliant
Means of Egress/Exit Door	75.56%	Mostly Compliant
Compartmentation	95.48%	Highly Compliant
Exit Signages	93.33%	Highly Compliant

Table VI presents the overall compliance rates of the assessed active and passive fire protection systems in selected commercial buildings. The compliance rates were derived from the percentage of compliant indicators evaluated based on the provisions of the 2019 Revised IRR of Republic Act No. 9514. The table consolidates the compliance results of individual indicators under each fire protection system and provides their corresponding interpretations. The findings show that smoke detectors (97.33%), compartmentation (95.48%), and exit signages (93.33%) obtained highly compliant ratings, indicating high adherence to fire safety provisions. Meanwhile, fire extinguishers (77.42%), automatic sprinklers (80.00%), fire doors (84.44%), and means of egress or exit doors (75.56%) were interpreted as mostly compliant. Overall, the results indicate generally satisfactory compliance among the assessed fire protection systems, although improvements remain necessary in selected indicators.

IV. CONCLUSION AND RECOMMENDATIONS

Conclusion

- The selected commercial buildings in Barangay San Isidro, Zaragoza, Nueva Ecija generally have available basic Active Fire Protection (AFP) systems, particularly fire extinguishers, while advanced systems such as smoke

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detectors and automatic sprinkler systems were found to have limited availability among several establishments.

2. The selected commercial buildings generally have available Passive Fire Protection (PFP) systems such as compartmentation and means of egress or exit doors. However, fire doors and exit signages were found to be lacking in several establishments, indicating deficiencies in some passive fire safety components.
3. The available fire protection systems in the selected commercial buildings were generally assessed to be in excellent physical condition based on the structured field observation checklist. This indicates that most installed systems were properly maintained and remained functional during the conduct of the assessment.
4. The assessed fire protection systems generally demonstrated mostly compliant to highly compliant ratings based on the provisions of the 2019 Revised IRR of Republic Act No. 9514. Smoke detectors, compartmentation systems, and exit signages obtained highly compliant ratings, while fire extinguishers, automatic sprinklers, fire doors, and means of egress systems showed areas requiring improvement, particularly in accessibility, visibility, obstruction-free operation, and evacuation-related requirements.
5. Based on the findings of the study, continuous fire safety monitoring, regular maintenance, and stricter implementation of fire safety regulations are necessary to improve the availability and compliance of fire protection systems and to strengthen fire safety preparedness among commercial establishments in Barangay San Isidro, Zaragoza, Nueva Ecija.

Recommendations

1. Commercial building owners and administrators should install additional Active Fire Protection (AFP) systems such as smoke detectors and automatic sprinkler systems to improve early fire detection and fire suppression capabilities within their establishments.
2. Establishments should improve the availability of Passive Fire Protection (PFP) systems, particularly fire doors and exit signages, to ensure safer evacuation and better control of fire and smoke spread during emergencies.
3. Regular inspection, maintenance, and monitoring of all installed fire protection systems should be consistently conducted to preserve their excellent physical condition and ensure continuous functionality and reliability.
4. Commercial establishments should strengthen compliance with the provisions of the 2019 Revised IRR of Republic Act No. 9514 by ensuring that fire protection systems remain accessible, visible, obstruction-free, and compliant with evacuation and fire safety requirements.
5. The Bureau of Fire Protection (BFP), barangay officials, and other concerned agencies should intensify fire safety inspections, awareness programs, and enforcement of fire safety regulations to further improve compliance and strengthen emergency preparedness among commercial

establishments in Barangay San Isidro, Zaragoza, Nueva Ecija.

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