Complience Evaluation Based on National Fire Safety Standards and QSPM Strategic Priority Analysis

Ahmad Jaelani[(1)], Norhayati[(2)], Anggi Kurniawan DA [(3)], Satrio Suseno Aji[(4)], Gunawan Siradjuddin[(5)], Putri Dwi Maryanti[(6)], Mohamad Ferdaus Noor Aulady[(7)]

Master of Industrial Engineering Study, Adhi Tama Institut of Technology Surabaya
Jln,Arief Rachman Hakim, 100 Surabaya
e-mail: nurcinta88@gmail.com

ABSTRAK

Kebakaran merupakan jenis bencana yang berdampak signifikan terhadap keselamatan manusia, kerugian materi, dan kelangsungan fungsi suatu bangunan. Penelitian ini bertujuan untuk mengidentifikasi kesiapsiagaan PT.XYZ terhadap potensi bahaya kebakaran serta merumuskan strategi penguatan yang prioritas. Metode penelitian yang digunakan adalah pendekatan *mixed methods* eksploratori berurutan yang dilengkapi dengan analisis SWOT dan Quantitative Strategic Planning Matrix (QSPM). Data dikumpulkan melalui observasi, wawancara dengan empat informan kunci, dan daftar periksa berbasis regulasi nasional. Hasil penelitian menunjukkan tingkat kepatuhan manajemen proteksi sebesar 86,7%, proteksi aktif 86%, dan proteksi pasif 85%, dengan rata-rata total 85,9% (Kategori "Baik"). Analisis SWOT mengidentifikasi celah kritis pada kompetensi SDM dan infrastruktur pasif. Hasil matriks QSPM menunjukkan bahwa Strategi Penguatan Kapasitas SDM & Sertifikasi Teknis merupakan prioritas utama dengan skor daya tarik tertinggi (TAS 2,65) untuk memitigasi risiko residu di lingkungan industri.

Kata Kunci: manajemen keselamatan kebakaran, sistem tanggap darurat, kesiapsiagaan bencana, SWOT, QSPM.

ABSTRACT

Fire is a critical disaster with significant impacts on human safety and building functionality. This study aims to assess the preparedness of PT. The research employs a sequential exploratory mixed methods approach, integrated with SWOT analysis and the Quantitative Strategic Planning Matrix (QSPM). Primary data were gathered through observations, interviews, and regulatory-based checklists. Results indicate a grand average compliance index of 85.9%, categorized as "Good". However, SWOT analysis reveals vulnerabilities in human resource competency and passive infrastructure. The QSPM results prioritize Human Resource Capacity Building & Technical Certification (TAS 2.65) as the most strategic intervention to address residual risks in high-risk industrial environments.

Keywords*: fire safety management, emergency response system, disaster preparedness, SWOT, QSPM.*

INTRODUCTION

Fire is a critical disaster that can cause significant losses to human life, property, the environment, and overall operational sustainability. In Indonesia, approximately 62.8% of fire incidents are caused by electrical failures, primarily short circuits, a risk exacerbated by inadequate spatial planning and limited firefighting infrastructure. Industrial areas face a higher level of fire risk due to the widespread use of flammable materials and complex operational processes[1].The Indonesian government has established a strict regulatory framework to mitigate this risk through Law No. 1 of 1970, Regulation of the Minister of Manpower No. 186 of 1999, and various technical standards such as SNI 03-1746-2000 and Regulation of the Minister of Public Works No. 26/PRT/M/2008 as the primary reference for the adequacy of protection systems and safety management.

Although numerous evaluations of fire preparedness have been conducted, significant methodological gaps remain in previous research. Studies by [2][3], for example, focused on cognitive aspects such as community knowledge and attitudes. Meanwhile, research in the industrial sector is often partial, evaluating only one dimension, such as independent emergency response organizations or the reliability of active protection systems, whout linking these to managerial policies.

The main contribution of this research lies in the development of an integrated compliance index that integrates the three main pillars of fire safety: protection management, active protection, and passive protection, which are measured quantitatively in a single analysis. This holistic approach is crucial for PT. XYZ, a manufacturing company that manages hazardous chemicals such as methanol and diesel, but still experiences small fire incidents due to a suboptimal emergency response system. By applying SWOT analysis and the Quantitative Strategic Planning Matrix (QSPM), this research goes beyond static technical assessments to provide strategic managerial policy direction, allowing the company to prioritize improvements amidst resource constraints to effectively mitigate residual risks [4].

METHOD

This study uses a sequential exploratory mixed methods design implemented in three main phases: a national regulation-based compliance audit (Ministry of Manpower Regulation, SNI, and Ministry of Public Works Regulation), a SWOT analysis to map internal and external factors, and decision-making using *the Quantitative Strategic Planning Matrix* (QSPM). Primary data were obtained through field observations, internal document reviews, and in-depth interviews with four key informants (HSE Manager and emergency response team). The number of four informants was considered sufficient because they represent the technical and managerial authorities who are fully responsible for the entire implementation of the emergency response system at PT.XYZ.
The level of preparedness is calculated using the following compliance percentage formula:

$$\text{Compliance} = \frac{Number\ of\ items\ fulfilled}{Total\ number\ of\ items}\ X100\%$$

Table 1. Fire Audit Assessment Criteria

Score	Description
≤ 60%	Poor
61% - 80%	Sufficient
81% - 100%	Good

RESULT AND DISCUSSION

The overall fire emergency response system at PT. XYZ is rated **Good** , with a total average conformance of 85.9% (Table 1). This indicates fundamental compliance with national standards.

Table 2. Recapitulation of Fire Emergency System Conformance

System Component	Average Conformance
Protection Management	86.7%
Active Protection	86.0%
Passive Protection	85.0%
Grand Average	85.9%

Although cumulatively PT. XYZ is in the "Good" category (85.9%), there is a residual risk gap of 14.1% which is concentrated at several critical points, namely;

- Human resource competency is the component with the lowest score (80%). This gap indicates that despite mature procedures and organization (90%), operational personnel still lack technical certification and hands-on training[5].
- The Alarm and Active Protection System identified challenges with alarm audibility in noisy areas and detector sensitivity in industrial environments (score 80%). The use of traditional, non-standardized equipment for chemical fires also presented a technical weakness [6][7][8][9].
- Passive infrastructure, namely emergency doors and stairs (score 80%) do not meet fire resistance standards (fire rating) and minimum width specifications according to industry regulations[10][11].

SWOT ANALYSIS AND QSPM

To formulate a strategy to strengthen fire preparedness at PT. XYZ, this study uses a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis followed by a Quantitative Strategic Planning Matrix (QSPM) to determine strategic priorities [4]

SWOT Analysis of PT. XYZ's Fire Preparedness

1. *Strengths* - Internal
   - High Regulatory Compliance: The Company achieved an average compliance index of 85.9%, which is categorized as "Good (G)" according to national standards.
   - Strong Procedural Foundation: The Emergency Response Procedures aspect achieved a score of 90%, supported by comprehensive SOPs, clear communication channels, and a regular inspection program.
   - Organizational Structure Established: Emergency Response Organization (ERT) has a clear division of roles (firefighters, medical, etc.) with a compliance rate of 90%.
   - Availability of Physical Fire Extinguishing Equipment: Fire extinguishers such as APAR, Fire Blanket , and *Glass Bulb* have a score of 90% with strategic placement.
   - Adequate Basic Evacuation Facilities: Evacuation routes and assembly points are clearly marked and free from obstacles (score 90%).

2. *Weaknesses* - Internal
   - Human Resources Competency Gap: The Human Resources component had the lowest score (80%), indicating a lack of technical certification and practical training for operational personnel.
   - Passive Infrastructure Weaknesses: Emergency doors and stairs (score 80%) do not meet the fire *rating* and minimum width standards required for industry.
   - Alarm System Limitations: The alarm system (score 80%) faces audibility challenges in noisy areas and potential detector sensitivity issues in industrial environments.
   - Non-Standard Traditional Methods: The use of traditional tools (sand/wet cloth) is considered ineffective for handling specific chemical fires such as methanol or diesel.

3. *Opportunities* (Opportunities) - External
   - Technology Modernization: Opportunity to integrate alarm systems with IT networks for automatic shutdown of high-risk production *equipment* [12] .
   - Capacity Building through Training: Implementing *hands-on training* for all operators in each *shift* can close the gap in HR competency.
   - National Standards Alignment: Opportunity to make structural improvements to fully comply with the technical specifications of SNI 03-1746-2000.
   - Development of Industry Index: The results of this study can be the basis for developing broader national fire safety audit reference standards.

4. *Threats* - External
   - High Risk Operational Characteristics: The use of highly flammable chemicals (methanol, diesel, oil) creates a more complex fire risk than public facilities.
   - Electrical Failure: Considering that 62.8% of fires in Indonesia are caused by short circuits, complex electrical installations in factories are a constant threat.

- False Sense of Security : The predicate "Good" can make management ignore residual risk of 14.1%, which can be fatal in high-risk industries.
- Mass Evacuation Obstacles: Weaknesses in the specifications of emergency doors and stairs threaten life safety during large-scale evacuations.

Managerial Implications Strategy (Strategic Action)

Based on the analysis above, PT. XYZ is advised to take the following steps:

- HR Priorities (WO Strategy): Changing dependence on modern equipment by increasing the certification and expertise of personnel in operating it.
- Detection Modernization (ST Strategy): Updating detectors to multi-sensors to address detection failures in noisy/dusty areas.
- Infrastructure Redesign (WT Strategy): Undertake long-term structural repairs to emergency doors and stairs to ensure the last line of defense (evacuation) functions optimally.

The QSPM (Quantitative Strategic Planning Matrix) method is used to objectively evaluate which strategies are the most prioritized to be implemented based on internal and external factors that have been identified in the previous SWOT analysis[13][14][15].
The following is a QSPM analysis to determine strategic priorities for PT. XYZ.

QSPM Matrix Analysis of PT. XYZ

In this matrix, we compare two main strategic alternatives that arise from managerial implications:

- Strategy A: Technology Modernization & Passive Infrastructure Improvement (Focus on physical assets).
- Strategy B: Strengthening Human Resources Capacity & Technical Certification (Focus on human capabilities).

Table 3. QSPM Matrix Analysis

Strategic Factors (SWOT)	Weight	Strategy A (Physical)	Strategy B (HR)
Strengths		**US**	**BAG**
Foundation of Good Procedures & Organization	0.15	2	0.3
Complete Physical Fire Extinguishing Equipment	0.1	3	0.4
Weaknesses			
HR Competency Gap (Lowest score 80%)	0.2	1	0.2
Passive Infrastructure & Alarms Are Not Standard	0.15	4	0.6
Opportunities			
Modernization of Detection Technology	0.1	4	0.4
Practical Training (Hands-on)	0.15	2	0.3

Threats			
Flammable Chemical Risk	0.15	3	0.45
Total Attractiveness Score (TAS)	**1**		**2.65**

The Quantitative Strategic Planning Matrix (QSPM) table, the following is an analysis of the strategic evaluation results for PT. XYZ:

1. Identify Key Strategic Factors

This analysis is based on the weighting of the importance of internal and external factors that influence fire preparedness:

- Key Strengths: The foundation of procedures and organization is considered very important (Weight 0.15) supported by the availability of complete physical equipment (Weight 0.1).
- Critical Weaknesses: The HR competency gap has the highest weighting (0.2) due to its lowest score (80%) in the compliance assessment. Furthermore, passive infrastructure and substandard alarms are also serious concerns (weighting 0.15).
- Significant Threat: The risk of using flammable chemicals (methanol/diesel) has a high weight (0.15), which requires a fast and accurate system response.

2. Comparison of Alternative Strategies

The table compares two main approaches to improving fire safety:

- Strategy A (Physical/Technical): Focuses on infrastructure improvements and equipment modernization. While essential for technical standards (AS 4 on passive infrastructure), this strategy is static if not properly operated.
- Strategy B (Strengthening Human Resources): Resulting in a Total Attractiveness Score (TAS) of 2.65. This strategy has high attractiveness because it directly targets the most critical weakness, namely personnel competency.

3. Interpretation of Results (Analysis Conclusions)

The QSPM results show that Strategy B (HR) is the top priority for PT. XYZ with the following considerations:

- Effectiveness of Response: Over-reliance on modern equipment will not be effective if personnel do not have the technical skills to operate it in an emergency.
- Residual Risk Mitigation: With a total compliance index of 85.9% ("Good"), the risk gap of 14.1% was most effectively closed through human capacity building (hands-on training) to handle complex chemical fire scenarios.
- Short-Term Priorities: Companies are advised to prioritize technical certification and practical training for all operators per *shift* before making major investments in passive infrastructure redesign.

Integration of QSPM Strategy and Top Priorities

The QSPM matrix results show that the Human Resources Capacity Building & Technical Certification Strategy is the top priority with the highest attractiveness score (TAS 2.65). This strategy was chosen as the main focus for the following reasons:

1. The Most Effective Residual Risk Mitigation: Reliance on modern equipment (such as APAR which reaches 90%) will be in vain if personnel do not have the technical competence to operate it accurately during an emergency.
2. Direct Solution to Biggest Weakness: This strategy directly targets the lowest compliance score companies (HR) to ensure a rapid response to hazardous chemicals (methanol and diesel).
3. Resource Efficiency: Human capacity building through hands-on training provides a faster and more significant resilience impact than static, long-term physical investments.

DISCUSSION

Conclusion of Main Findings

PT. XYZ's fire preparedness index reached 85.9% (category "Good"). However, there is a residual risk of 14.1% originating from critical gaps in Human Resources (HR) competency and passive infrastructure specifications. This finding indicates a contradiction: the availability of adequate physical equipment (90%) will not provide optimal protection if operational personnel do not have the technical certification and practical expertise to respond quickly to emergency conditions.

Concrete Action Steps and Priorities (Managerial Recommendations)

Based on the results of the QSPM analysis which places strengthening HR capacity as the main priority (TAS 2.65), PT. XYZ is advised to immediately implement the following steps:

1. Competency Transformation Through Periodic Certification (Short-Term Priority) requires companies to shift from internal outreach to hands -on training and technical certification programs for all operators on every *shift* . The primary focus is on proficiency in the use of fire extinguishers (APAR) and hydrants in chemical fire scenarios (methanol/diesel) to close the competency gap, which currently stands at 80%.
2. The Detection Modernization and System Integration Roadmap (Medium-Term Priority) addresses the limitations of alarm audibility by modernizing detectors to multi-sensor systems integrated with an IT network. This system should include an automatic shutdown feature on high-risk production equipment to mitigate the risk of electrical failures, which are a major cause of industrial fires.
3. National Standard Passive Infrastructure Redesign (Long-Term Priority) involves structural improvements to emergency doors and stairs to fully meet fire rating specifications *and* minimum width dimensions according to SNI 03-1746-2000. This is crucial as the last line of defense to ensure life safety during mass evacuations.

Limitations of Further Research and Evaluation

This study has limitations because it focuses on a single location (a case study of PT. XYZ) and uses a checklist-based assessment instrument that relies on current national regulations.

Therefore, further evaluation through full-scale fire drills is needed to test the effectiveness of actual response times. Future research is also recommended to expand the scope to various types of manufacturing to develop an Industrial Fire Preparedness Index that can be generalized nationally.

CONCLUSION

PT. XYZ's preparedness level of 85.9% represents a superior position compared to several studies of public facilities. In comparison, studies in the healthcare sector (community health centers) or universities often show lower preparedness indices due to limited infrastructure budgets and a lack of routine simulations. However, for manufacturing plant environments that use hazardous chemicals such as methanol and diesel, this "Good" category still carries significant residual risks.

There's a contradiction worth highlighting: although the average index indicates adequate conditions, a small 20% gap in human resources and passive structures can be fatal in high-risk industries. Overreliance on the availability of modern equipment (such as 90% fire extinguishers) will be ineffective if not accompanied by adequate human competency to operate them in an emergency. Furthermore, weaknesses in structural safety (emergency doors and stairs) can hamper mass evacuations, which are the last line of defense for saving lives.

The implication of these findings is that PT. XYZ should not be trapped in a false sense *of security* due to its "Good" reputation. The company must immediately shift from simply meeting minimum standards to a framework of continuous improvement, with a primary focus on personnel certification and improving the technical specifications of its passive infrastructure.

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