Enhancing Business Continuity: An MCDM-Based Assessment of Fire Risk Management Measures

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Abstract: - At times, organizations' continuity often largely hinges upon their ability to operate the business even if and when fire danger arises. The study, calls for the development of the Multi-Criteria Decision Making (MCDM) methods to evaluate and ameliorate fire risk management measures. It is a novel strategy, which is presented in this empirical work. By combining MCDM tools, such as the decision-making method of Analytic Hierarchy Process (AHP), entropy, and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), this study brings holistic and data-driven solution to company's fire safety management to allow them to prioritize and figure out the best fire risk management strategy.

This abstract focuses especially on the enterprise level of the evaluation methodology of a fire risk management model with primary attention to the integration of MCDM, as a powerful tool for the solution of complex decision-making issues. Organizations should organize their priorities according to multiple objectives, for example, cost-efficiency, compliance, and effect on operations that create conditions for making the right decisions concerning the mitigation of fire risks while preserving business continuity. The findings of the research give a boost to the work of proactive and adaptable fire risk management strategies development, which are organized according to the requirements and peculiarities of enterprises.

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Key-Words: **-:** Privacy Fire risk management, Business continuity, Multi-Criteria Decision Making (MCDM) methods, Analytic Hierarchy Process (AHP); Entropy; TOPSIS

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1 Introduction

Fire incidents, whether they occurred or not, can always present a noticeable business threat that may involve property damage, financial losses, disruption in operations, or risk of loss of reputation. In order to ensure a business continuity facing such risks for each organization its own set of fire risk management measures are needed tailored to the individual circumstances of the organizations. In the majority of cases, the standard

Way of fire risk management usually involves using corresponding implementing strategies and specific regulations, which might not be fully applicable to different business needs or priorities.

The formulated strategies represent the proposed framework for continuous business performance under a fire risk management environment through the employment of Multi-Criteria Decision-Making (MCDM) techniques. The framework of MCDM techniques provides a structured and inclusive foundation on which organizations can base their evaluation of possible courses of action that are multi-criteria and as such facilitate their decision-making process in terms of what aligns with their goals and limitations.

The purpose of the present research is to provide a systematic approach that would allow us to identify and prioritize fire risk management measures while considering the business point of view. Through lessons in Multicriteria Decision Making (MCDM) methodologies including Analytic Hierarchy Process (AHP) and Technique to Order Preference by Similarity to Ideal Solution (TOPSIS), we will equip the business with a strategic system for evaluating the profitability and practicability of different fire risk management plans. In the course of this article, we will explain the necessity of using MCDM tools for fire safety management, a various literature review, and a tentative structure of the suggested framework for a fire safety management measure assessment will be served. In extension, we will be introducing a situation simulation through which one will have a better understanding of the framework as the organizations manage to prevent the incidence of fire hazards while operation remains steady. But, through incorporating the MCDM-evaluation model into their fire hazard risk management policies, the organizations can actively discover and choose the most efficient measures that will balance risk reduction, cost-effectiveness, and continuous business performance. The approach enables firms to not only lower the exposure to losses and damages caused by fire but also ensures they can easily deal with what one would describe as a new phenomenon whose root cause they cannot predict.

2 Literature Survey

The management of fire risk is an issue that has consumed large amounts of time and energy to be invested in it by different areas of interest and study in engineering, risk assessment, business continuity, and decision sciences, to mention but a few. This literature survey is purposefully done to explain the conceptual framework of the present studies and methodology briefly in order to utilize it in the analysis of measures for fire protection, specifically using Multi-Criteria Decision Making (MCDM) methodology in promoting business continuity [1], [2], [3], [4], [5]. Fire risk management until today has had a prime prescriptive character and relation-oriented with codes and standards, home building regulations, fire safety standards, and best industry practice. These types of fire safety offer only minimum provisions and there is some shortage of adjustment and failure to give proper attention to the individual requirements of the organizations [6], [7], [8].

Again, MCDM has become a powerful instrument to combat this problem in a world where many factors cannot be predicted easily and are in doubt [9], [10], [11], [12]. Technique has evolved as an excellent procedure used to solve this intricate and the problems with forecasting in the world where variables are ambiguous and uncertain circumstances[13], [14], [15], [16], [17]. Thus, the above techniques offer the decision-makers the room to contrast different incompatible alternatives with different criteria with quantitative and qualitative parameters, which in turn enable them to select the optimal solution catering to multiple goals on board. Several research articles have highlighted the utilization of MCDM techniques in comparing powder scenarios for managing fire risk [18], [19], [20]. Some of the researchers utilized AHP (Analytic Hierarchy Process) to determine the sequence of implementation of fire control measures in high-rise buildings. AHP was established based on such criteria as effectiveness, cost-feasibility, and sequence [21], [22]. Similarly, they utilized some of them to implement Materialization of Order by the Analytical Hierarchy Process (TOPSIS) to run fire risk management alternatives in industrial plants based on parameters like safety performance, environmental effect, and economic efficiency [23], [24].

The concepts of business continuity and disaster recovery have been of paramount concern to organizations, which would like to anticipate and mitigate the effects of-just for naming a few-fires, disruptions-on their business processes, as well as on their stakeholders' interests. Interest has been keen in studies of this type, which reiterates that risk management procedures need to be anticipatory and interpret the business objectives and make them safety focused [25], [26], [27], [28]. MCDM techniques, while having wide visions of use in developing the business continuity through proper management of fire hazards, the usability of such methods is yet to be ascertained. Amongst these problems is selecting adequate criteria and adequate decision-making frameworks [29], [30], [31], [32]. In addition to this, the assignment of some personal views and expert knowledge are related to this. However, the issue accumulates if one translates the results into practice.

After a short definition, the literature review shows how the MCDM techniques developed into business continuity in respect of fire risk management. By collecting, analyzing, and combining existing research, this paper will develop a helpful approach to methodology in studying fire management policies from the business side according to the MCDM principles in order to assist in the decisions of the enterprises involved and their shift in strategy [33], [34], [35], [36], [37], [38].

3 Methodology

The methodology explains the suggested approach for the application of MCDM to determine the suitability of fire risk management measures in increasing business continuity. This part is about explaining the research process according to the above framework giving detailed descriptions from criteria selection and data collection until the application of the MCDM method and resulting interpretation.

1. Identification of Criteria	**The first step involves identifying relevant criteria for evaluating fire risk management measures from a business perspective. These criteria may include but are not limited to:** ✓ Effectiveness in mitigating fire risks ✓ **Cost-effectiveness of implementation** ✓ **Compliance with regulatory requirements** ✓ **Impact on operational continuity** ✓ **Environmental sustainability** ✓ **Stakeholder acceptance and perception** ✓ Resilience to future uncertainties
2. Data Collection and Evaluation	Data related to each criterion are collected and evaluated through a combination of literature review, expert consultation, and empirical analysis. This may involve gathering information on the performance and characteristics of various fire risk management measures, as well as assessing their potential impact on business operations and outcomes.
3. MCDM Technique Selection	Based on the identified criteria and available data, an appropriate MCDM technique is selected for the assessment. Commonly used methods include Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Multi-Attribute Utility Theory (MAUT). The chosen technique should align with the decision context and preferences of stakeholders.
4. Weighting and Normalization	The criteria are weighted to reflect their relative importance in the decision-making process. This may involve soliciting input from stakeholders through surveys or interviews to determine their preferences and priorities. Additionally, the dta are normalized to ensure comparability across different criteria and alternatives.
5. Evaluation of Alternatives	Fire risk management measures are evaluated against the established criteria using the selected MCDM technique. This involves scoring each alternative based on its performance with respect to each criterion and aggregating these scores to generate an overall ranking or preference order.
6. Sensitivity Analysis	Sensitivity analysis is conducted to assess the robustness of the results and identify potential sources of uncertainty or variability. This may involve testing the effects of changing criteria weights, data inputs, or decision parameters on the final outcomes.
7. Interpretation and Decision Support	The results of the MCDM analysis are interpreted in the context of business objectives and constraints. This may include identifying trade-offs between competing criteria, exploring sensitivity to different scenarios, and providing decision support to stakeholders in selecting optimal fire risk management measures.
8. Validation and Iteration	The final step involves validating the findings of the MCDM analysis through peer review, validation testing, or comparison with real-world case studies. Feedback from stakeholders is solicited to identify areas for improvement and refine the methodology for future applications. By following this systematic methodology, organizations can effectively assess and prioritize fire risk management measures based on their impact on business continuity, thereby enhancing their resilience to fire hazards and other disruptive events.

Figure 1: Systematic Methodology

Organizations will then be able to adequately weigh and prioritize fire risk management measures related to their business continuity course by using this stepwise approach and consequently increase their fire resilience, which is a substitute for resilience to any movement that can pose a threat to it.

3.1 Mathematical Model

The MCDM-based mathematical model illustrates the evaluation of fire risk management alternatives, though, qualitatively examines the most robust strategies based on the multiple criteria. Below is a general framework outlining the mathematical outlining the model:

Represent by n separate measures $X_1, X_2, X_3, \dots, X_n$, which are fire risk management measures or alternatives. Let $X_1, X_2, X_3, \dots, X_n$ represent n fire risk management measures or alternatives under consideration. Let $C_1, C_2, C_3, \dots, C_m$ represent m evaluation criteria.

For each alternative X_i, (i = 1, 2, ..., n), and each criterion C_j, (j = 1, 2, ..., m), we define:

w_j: Weight assigned to criterion C_j reflecting its relative importance.

x_{ij}: Performance score of alternative X_i with respect to criterion C_j

S_i: Overall score of alternative X_i, calculated as the weighted sum of its performance scores across all criteria. The mathematical model can be represented in Figure 2.

1. Weight Assignment	$\sum_{j=1}^{m} w_j = 1$ where w_j represents the weight assigned to criterion C_j, ensuring that the weights sum up to one.
2. Performance Evaluation	$S_i = \sum_{j=1}^{m} w_j \times x_{ij}$ The overall score $S_i$of alternative $X_i$is calculated as the weighted sum of its performance scores across all criteria.
3. Ranking of Alternatives	Alternatives are ranked based on their overall scores S_i with higher scores indicating better performance. The ranking provides a preference order for the fire risk management measures, guiding decision-making towards selecting the most suitable alternatives.
4. Sensitivity Analysis:	Sensitivity analysis may involve varying the weights assigned to criteria w_j or adjusting the performance scores x_{ij} to assess the robustness of the rankings and identify influential factors affecting the decision outcomes.
5. Interpretation and Decision Support:	The results of the mathematical model are interpreted in the context of business objectives and constraints, providing decision support to stakeholders in selecting optimal fire risk management measures. Sensitivity analysis and scenario testing may be used to explore trade-offs and uncertainties, aiding decision-makers in making informed choices.

Figure 2: Representation of Mathematical Model

In this theoretical model, the fire risk management measures are going to be evaluated and prioritized through the way they impact business continuity at systemic level. This then would facilitate effective decision-making and appropriate risk mitigation strategies.

3.2 Evaluation of Methodology

Evaluation of the MCDM-driven assessment of fire risk management procedures utilizes examining the outcome as a result of applying a mathematical model and their credibility in terms of relevance and stability in the framework of business continuity. Through a meticulous scrutiny of the outcomes from the MCDM-based aforementioned fire risk management assessment, organizations can ensure that their decision-making processes are enhanced increasing their resilience to fire hazards and keeping their business continuity in the face of a potential disruption.

3.3 Analysis with Computational Intelligence

The overall evaluation process is enriched by the application of methods of computational intelligence to MCDM evaluation. Basically, the computational intelligence techniques include various algorithms and strategies, which are the imitation of our natural intelligence, for example, the artificial neural networks, fuzzy logic, genetic algorithms, and swarm intelligence.

1. Validity Assessment	The criterion that relies on the accuracy of the assessment in measuring what it is supposed to measure is referred to as validity. The aim of this stage is to study the accuracy of evaluation criteria, data contributes, weighting scheme, and mathematical model to check if they serve the objectives of the study and the needs of the stakeholders. Such methods as experts' judgment and peer review may be used to check the need and relevance of the assessment framework created.
2. Reliability Analysis	A reliable assessment is defined as a consistent and stable process that brings about the same results regardless of time and conditions. To examine reliability, a sensitivity analysis which is based on evaluating the level of robustness and sources of uncertainty or variability in the rankings is used. This implies that the performance evaluation could be done as the results of changing the weights of the criteria, the data inputs, or any decision parameters. The reliability of the methodology which is the basis for the evaluation process plays a crucial role because it affects the decision-making process as well as the conclusions.
3. Relevance to Business Continuity	The measurement of the efficiency of fire safety and risk management measures is taking place in the business continuity context where the organization resilience and sustainability are most concerned. the interpretation of the result by business objectives, constraints, and the risk tolerance threshold is done to determine whether the implications for decision-making based on these results are practical and feasible. Input from stakeholders and feedback are sought at the end of the evaluation process is assessed validity of the results and aligned with the priorities of business.
4. Decision Support and Actionable Insights	During the evaluation stage, decision-making gets facilitated for stakeholders by providing recommendations and implementable outputs that foster business continuity through the adoption of suitable fire risk management techniques. The study results are used to suggest priorities for future activities and to develop a mitigation plan that successfully balances the various trade-offs between options and constraints, while aiming to improve organizational resilience. Policymakers coming from the decision process now arm with decision logic based on evaluation results, provided by qualitative and quantitative data.
5. Documentation and Communication	The whole thing is diligently documented to ensure purity of information, transparency, and the transfer of knowledge. In the conducted evaluation framework an insightful report is written comprising methodology, main points from the assessment results followed by significant actions to be taken for business continuity and future directions. The product of evaluation is communicated to the authorities responsible and other relevant stakeholders through presentations, workshops and other channels to increase the understanding and to make sure of the buy in form of other stakeholders.

Figure 3: Outlines key aspects of the evaluation process.

By acknowledging the inclusion of cognitive intelligence technology into the analysis of fire risk management measures in the MCDM framework, there is the chance to use the strength of high-level algorithms for improved decision-making, improved predictive precision, and the optimization of business resilience strategies in the face of the fire hazards as well as other disruptive events.

4. Case Study

This study will be continued by evaluating 8 enterprises several times on the basis of 3 criteria and 34 sub-criteria relative to fire risk management and evaluated in the statistical values. The list of criteria and sub-criteria are at the end of the appendix.

1. Data Preprocessing and Feature Engineering	Computational intelligence methods can be used for data pre-processing connected to fire risk management, extracting useful features. For example, using methods like dimensionality reduction, outlier detection, and data normalization allows for cleaning input data and the effectiveness of your later analysis can be improved.
2. Modeling Complex Decision Spaces	Every fire risk management problem that we face is an example of the complicated decision making space, which includes multiple factors and uncertainties that interact with each other. We should emphasize on computational intelligence methods as genetic algorithms and particle swarm optimization are good in exploring the space of solutions and finding either the optimal, or close to optimal solutions of complex optimization problems. These techniques may be taken advantage of to discover effective fire risk management techniques which will be robust enough to ensure business continuity while making reference to complex constraints and objectives.
3. Predictive Modeling and Risk Assessment	Computational intelligence methods that include artificial neural networks and fuzzy logic, can be the basis to develop prediction models for fire risk evaluation and computing the effect of fire on business continuity. Through data analysis focusing on historical data on fire incidents, property damage, and operational disruptions, these models are capable of providing organizations with useful information relating to the probable occurrences and impact of similar events, enabling businesses to respond to potential risks and allocate important resources wisely.
4. Adaptive Decision Support Systems	The computational intelligence techniques help in forming the adaptive decision support systems which aptly receive feedback from the real-world results and thereby continuous evolve with time. Utilizing feedback processes and adaptive learning algorithms, the systems are capable of adjusting the fire risk management strategies according to the changing environment, regulation, and user references. This evolutionary feature makes them suitable for the rapidly developing and evolving environment.
5. Interpretability and Explainability	Though the computational intelligence techniques being used usually exhibit high predictive performance, it is quite difficult for stakeholders to comprehend the rationale behind decision recommendations because of their lack of transparency and interpretability. Efficiently dealing with this problem implies the formulation of common transparent and interpretative algorithms that readily reveal how different variables contribute to a particular decision outcome. The creation of human-understandable reaction was possible like rule extraction from neural networks and use of fuzzy logic-based decision trees that could contribute to trust and transparency in the evaluation of fire defense measures.

Figure 4: The ways the MCDM framework's evaluation of fire risk management measures may benefit from computational intelligence

4.1 Disclosure of criteria with identification of selection options and criteria

The importance of fire risk management systems and criteria has been measured using the entropy-based and TOPSIS methodology, based on the literature study and the data obtained from 34 sub-criteria prepared for 8 operations.

4.1.1 Calculations and Analysis

Evaluation of Fire Risk Management Systems for Operations. Businesses will be dealt with by 3 main criteria: Criteria 1: Organizational; Criteria 2: Technical; Criteria 3: Human

4.2 Entropy Method

There are 4 steps in Entropy method, which are:

Step1: Perform normalization operation

Initially, a normalization process must first be carried out in order to be able to evaluate between different dimensional criteria for a decision matrix of $m \times n$ dimensions. If the criteria have different scale units, an incorrect evaluation will occur (in

Table 1). The normalization process is done with the following formula (in Table 2).

Table 1: Participant information for each business

Business	Number of Participants	Experience (Year)
$İ_1$	9	11
$İ_2$	c 9	13
$İ_3$	12	5
$İ_4$	7	14
$İ_5$	7	13
$İ_6$	8	11
$İ_7$	9	8
$İ_8$	7	6

$$r_{ij} = \frac{x_{ij}}{\sum_{P=1}^{m} x_{pj}} \qquad i = 1,2,\dots,m \qquad j = 1,2,\dots,n$$

$$r_{ij} = \frac{x_{ij}}{\sum_{P=1}^{m} x_{pj}} i = 1,2,\dots,mj = 1,2,\dots,n$$

(1)

A normalized decision matrix is created with equation of $R = [R_{ij}]_{mxn.}$

Step2: Obtaining entropy values

The entropy value or uncertainty measure value for each of the criteria is calculated using the formula given below.

$$e_j = -k \sum_{i=1}^{m} r_{ij}.\, ln r_{ij} \qquad j = 1,2,\dots,n \tag{2}$$

Here, k value refers to the constant number defined by $\frac{1}{lnm}$.

Step 3: Finding degree of differentiation

Using the obtained entropy value, the degree of differentiation values for each criterion are calculated using the formula given in below:

$$d_j = 1 - e_j \qquad j = 1,2,\dots,n \tag{3.}$$

Step 4: Getting the weight value

The weight values of the criteria are obtained by dividing the degree of differentiation of each criterion to the total degree of differentiation. In the expression given below, the wj value represents the weight of the j-th criterion. The sum of the weights is equal to 1[39].

$$d_j = \frac{d_j}{\sum_{P=1}^{n} d_j} \tag{4}$$

4.2.1 Results of Entropy Method

This section presents organizational part discussing technical, human, personnel, and management viewpoints. Use that method to illustrate the connection between elements and employees.

Table 2: Statistics of the survey dedicated for this study

Business	Number of distributed Survey	Total number of Survey	Answer Ratio (%)
İ1	12	9	75
İ2	13	9	69
İ3	17	12	71
İ4	11	7	64
İ5	10	7	70
İ6	12	9	70
İ7	10	8	80
İ8	11	7	64
Total	96	68	71 (Avg)

According to the example given, top management roles had a share of 58%, with the organizational dimension having the highest influence (38%), while the influence was 40% for the human dimension. At the staff level, 49 percent of human elements of fire-risk management systems were the most affected, while 46 percent of organizational elements was the second. The minimum impact rates for the technical aspects were 2% for managers and 6% for staff represented respectively (in Figure 5). The main elements are comprised of the following. The results of each operation were computed using entropy and are shown on Table 3. Human and organizational aspects presented the lowest impact on the fire risk management system at each enterprise in comparison to technical aspects. For example, at (İ6) human factors had the highest impact (52%), technical factors had the lowest impact (2%), and organizational factors 46 percent (in Table 3). According to the findings depicted in Table 3, the human elements of aspects are the most important for businesses 1, 4, 6, and 8 (I1, I4, I6, and I8), and the organizational factors are most important for Businesses 3, 5 and (I3, I5, and I7). As Figure 6 illustrates, the human factor was by far the most outstanding factor in the entire fire risk management system of surveyed undertakings, representing around 48%. Organizational issues were ranked number two with 45 and technology was the least important aspect according to 7 per cent of respondents.

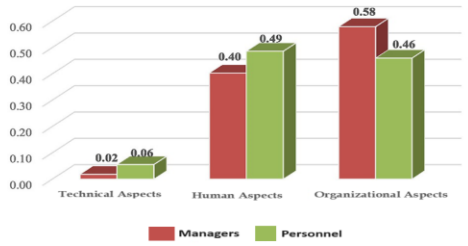

Figure 5: Weight calculation at staff and manager levels

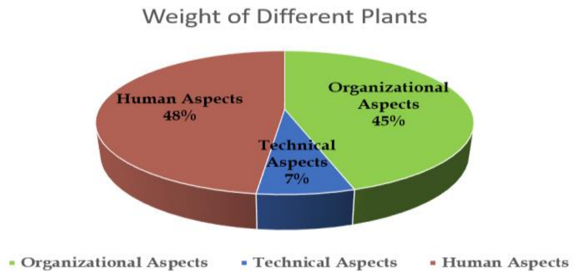

Figure 6: Calculation of the weight of different plants

4.3 TOPSIS Method

The TOPSIS expansion is called the Technique for Order Preference by Similarity to the Ideal Solution, which was first elaborated by Hwang and Yoon in 1980 and presented to science. The core of the method is located at the proximity of the decision points to the best alternative. [40] TOPSIS is among the frequently used ways to come to a decision concerning the weights of criteria because of its easy understanding, simplicity in calculation, and its reasonability [41].

TOPSIS Method has 6 steps as illustrated in below:

Step 1: Designing Decision Matrix

The decision matrix, with rows containing the criteria and columns alternative, is as follows.

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix} \quad (5)$$

In the Aij matrix, m m is the total number of the alternatives and n is the total number of the criteria.

Step 2: Making the Standard Decision Matrix

As the unit measurements of data in decision matrix are different, the data is normalized by applying a scale transformation on the data. The standardized decision matrix A, presented in the figure below, was derived from starting matrix. N_{ij} values in this matrix are obtained using the formula below.

$$n_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \quad (6)$$

Step 3: Developing Weighted Standard Decision Matrix

The value of the criterion's weight is indicated by W_i $(\sum_{i=1}^{n} w_i = 1)$ Multiplication is done between the elements of the R matrix columns and W_i values. Consequently of this operation, the V matrix is found.

Step 4: Obtaining Ideal (A+) and Negative Ideal (A-) Solutions

As for the selection of the best solution in the V matrix (the solution of a strategic assignment), maximum scores pursuing the criteria are needed, therefore values in the column meant for the solution should be chosen. The building relation is below to give the ideal solution.

$$A+ = \{\max V_{ij} \mid j \in J, \min V_{ij} \mid j \in J\} \quad (7)$$

To acquire the negative objective function the smallest signs of all the criteria values on the last column of the V-matrix are chosen besides which values are selected. Opposite to the ideal solution theory, various assumptions offer different total ideal solution values.

$$A- = \{\min V_{ij} \mid j \in J,, \max V_{ij} \mid j \in J\} \quad (8)$$

The solution of the above formula will be A- = $\{V_1-, V_2-, \ldots V_n-\}$ from the set –Vn

The group of real numbers, which will be the final result in the formula, can be written in form A+ = $\{V_1+, V_2+, \ldots\}$ .Vn+}

Step 5: Validate the prejudice indicators

Consistently a good discrimination value $(S_i)+$ and a bad discrimination value $(S_i)-$ are the difference values reserved for the alternatives. Below are the formulas that are used throughout the calculation.

$$S^+ = \sqrt{\sum_{j=1}^{n} (V_{ij} - v_j^+)^2} \quad (9)$$

$$S^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - v_j^-)^2} \quad (10)$$

Usage of (Si)+ equals (Si)- within the number of alternatives is the same.

Step 6: Calculate the relative being brought closer to the optimal solution. $(C_i)^+$ index of closeness is achieved when the difference between the alternatives and that of the optimum solution has been computed. Value of this variable is in the range of the mathematical expression between $0 \leq (C_i)^+ \leq 1$. The vanishing point of the ideal solution remains the same regardless of the value. Properly prioritizing the alternatives based on their resemblance to the perfect solution. Human $(C_i)^+$ values participation in getting the alternatives' proximities to the ideal alternatives. Measuring the universe's apparent age is accomplished mathematically through the formula. $(C_i)^+$ values are taken into account in obtaining the relative closeness of each of the alternatives to the ideal solution. This value is obtained using the formula shown below.

$$C_i^+ = \frac{S_i^+}{S_i^- + S_i^+} \quad (11)$$

$(C_i)^+$encourages the adoption of a value of varying degrees between 0 and 1. $(C_i)^+= 1$ represents how close an alternative's ideal solution is and $(C_i)^+=0$ portrays approval of the ideal solution which is negative [42], [43].

4.3.1 Results of the TOPSIS Method

The outcome of this step on TOPSIS indicated that I1 (Operation 1) gets the highest closeness (0.979). As for the workshop, it generates the readings with the highest ideal resolution (0.002). The results presented a closeness score of 0.897 with I5 (Operation 5), which is 2nd highest among all firms after another one. The conclusion of weighting elements of each trade in Table 3 tells us that the human aspect was the primary influence with 48% of total weight.(Table 3). The table results illustrated that the human element plays a vital role for I1 (Project 1) in which the weight of this element is higher than 48% (more than half). This not only proves but also becomes the main reason why I1 stands first on the list.

Table 3: Weight Calculation of each enterprise in three directions.

Business	Technical	Human	Organizational
İ1	0.07	0.53	0.40
İ2	0.04	0.48	0.48
İ3	0.02	0.47	0.51
İ4	0.16	0.47	0.37
İ5	0.07	0.46	0.47
İ6	0.02	0.52	0.46
İ7	0.12	0,35	0.53
İ8	0.04	0.52	0.44
Total	0.07	0.48	0,46

Sorting and analyzing eight firms according to the risk management functionality data is one of the important tasks that the study fulfilled. The AHP method of MCDM was represented as the TOPSIS approach and was used to rank. Table 4 shows the decision matrix for eight business firms. First of all the step in the TOPSIS method is the calculation of the normalized decision matrix using formula (6). The weighted decision matrix is then calculated and the results are shown in the Table 5. The fact remains that the weighted decision matrix acquires shape when the normalized decision Matrix collides with the summa weight of the elements presented in Table 5. There are two types of solutions which are known as ideal and negative ideal and they are calculated using the equations (7) and (8). The gaps between the ideal and negative ideal solutions are calculated using Equations (9) and (10) shown in Table 6. The table also offers equation 11 corresponding to the relative proximity to the ideal solution by it.

Sorts out the study aim by prioritizing and classifying the eight objectives. We are carrying a research in order to examine how the fire risk management systems were handled from both technical, human and organizational viewpoints in eight different businesses. The data which was used in this research was acquired through, of course, a survey. Two types of TOPSIS (which is shortened from Technique for Order Preference by Similarity to Ideal Solution) were employed to make the analysis. The weight of risk management systems has been found using a method of entropy calculation. The TOPSIS method was applied and was used to rank eight companies with regard to their fire risk management systems which were also evaluated where their levels of risk were measured.(Table 6).

Table 4: The decision matrices of operating enterprises.

Business	Technical	Human	Organizational
İ1	3.364	3.656	3.88
İ2	3.525	3.000	3.316
İ3	3.439	2.983	2.897
İ4	3.286	3.557	3.714
İ5	3.494	3.543	3.846
İ6	3.438	3.640	3.736
İ7	3.128	3.230	2.898
İ8	3.494	3.530	3.850

Table 5: Normalized decision matrices

Business	Technical	Human	Organizational
İ1	0.031	0.230	0.220
İ2	0.032	0.207	0.207
İ3	0.032	0.187	0.164
İ4	0.030	0.224	0.211
İ5	0.032	0.223	0.218
İ6	0.032	0.227	0.215
İ7	0.030	0.215	0.165
İ8	0.032	0.220	0.217

Table 6: The rankings of all alternatives (operations) are calculated by relative proximity

Business	Distance of ideal Solution	Distance of Negative Ideal Solution	Proximity	Order
İ1	0.002	0.070	0.979	1
İ2	0.039	0.031	0.443	6
İ3	0.070	0.001	0.020	8
İ4	0.012	0.059	0.836	4
İ5	0.007	0.064	0.897	2
İ6	0.069	0.001	0.830	5
İ7	0.003	0.035	0.022	7
İ8	0.006	0.063	0.892	3

5. Conclusion

Thus, the MCDM approach of fire risk management measures seeks a systematized and data-driven technique in forestalling any business continuity damage due to fires. With the usage of multi-criteria decision-making approaches, organizations can choose and rank optimal strategies; prioritize interventions, and optimize the usage of resources effectively to curb fire risk and enhance the resilience of the operations. Through identifying and upholding fire risk management measures organizations can become more than one step forward concerning firefighting incidents and will, therefore, be able to eliminate potential interruptions in operations, damage to the property as well and ruining the company's reputation. Efficient fire risk management economizes the resilience of organizations to enable efficient operations to run in non-mellow situations, protect staff, customers, and assets, and develop the public's confidence regarding the organization's ability to deal with emergencies.

The appropriate implementation of fire risk management actions will only be achieved in the situation of a partnership and involvement of internal and external stakeholders among which employees, management, regulative bodies, insurers, and inhabitants might be outlined. Via stakeholder cooperation and linkages, both organizations emphasize collaborative skills and knowledge sharing, which contributes to increased fire safety and continuous business' operations. Going ahead, organizations shall take upon the responsibility of the continuous assessment, adjustment, and amendment of the management strategies for fire risks in the face of accurate environments. Moreover, it is essential to conduct additional studies to discover the new trends, technologies, and top strategies and approaches to preventing fires and building fire resistance.

In essence, this MCDM approach offers a comprehensive and forward-thinking solution for fire risk mitigation that is designed to protect organizational continuity and resilience by securing the organization against the loss of assets from fire hazards. Through the deployment of the intelligence obtained through this process, the finance capacities, the fire response readiness, and the organization's resilience to fire incidents are increased, hence stakeholders get protection and success is sustained in the long run.

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Appendix

Organizational

1- Fire risk management?
2- Periodic different group training?
3- Emergency evacuation and communication?
4- Risk manoeuvre operation?
5- Use of literature on fire risk?
6- Fire risk management response?
7- A post-fire emergency plan?
8- Young Employee Resource?
9- Reward system for fire risk management?
10- Employee needs?
11- Information about the causes of fire risk?
12- Fire risk meeting and external instructor?
13- Efficiency of courses, training and meetings?

Human

1- Fire risk management members qualifications?
2- Continuity and monitoring of training in fire risk management?
3- Are staff / employees willing to fire prevention and practices?
4- Participation of staff / staff in fire training?
5- Are fire risks management managers / officials adequate?
6- Fire management and training motivation of employees?
7- Compliance with instructions and procedures?
8- Measuring and evaluating staff competence?
9- Participation of managers/officials in fire-related organizations?
10- Have the procedures for carrying out humanitarian activities changed since the fire risk management system was established?

Technical

1- Equipment protector?
2- Updates of equipment?
3- Development of process equipment?
4- Hazard analysis of process equipment?
5- Periodic equipment maintenance?
6- Human error in the design of equipment?
7- Work permit system for equipment repair?
8- Is the equipment safe?
9- Process alarm system in the equipment?
10- Detector and sensor systems of the equipment.
11- Safety and firefighting systems such as sprinkles and emergency cooling?