Provide a Model for Improving Work Safety Value Using Fuzzy Performance Indicators: A Case Study of Small Scale Power Plant

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ABSTRACT

Today, occupational accidents, like one of the substantial agents in the damage of efficient human resources, money and time, are considered a menace to the extension and improvement of each state. These accidents have a massive stroke on the productivity of the laborer of different industries and eventually in the economy of society.
The purpose of this study is to provide a model to improve safety value, according to productivity indicators in manufacturing industries. In most studies, the cost of each damage has often been used for the calculation of the safety-related costs in the workplace, and this important issue is still neglected despite the high impact of job productivity loss due to occupational accidents. hence, on the present etude, the multi-criteria decision-making (MCDM) method has been used to present a model to improve the safety value according to the proposed solutions. The results showed that among the studied criteria, capital productivity had the most impact and holding classes and training courses for the workforce, according to the studied criteria was identified as the most appropriate solution to improve the value of safety

Keywords: Safety Value, Productivity, Management Accounting, Cost of Safety

INTRODUCTION

The development of industries and advancement of technologies have had adverse effects, in addition to positive effects. Problems such as the increased environmental and workplace pollution, occupational accidents and occupational diseases are among the consequences that have affected the lives of humans in general and workers in particular with the development of industries and technologies. This is more evident in developing countries [1], where working hours standards, the education of laborers and the usage of appropriate personal protective equipment for laborers put more pressure on workers regardless of the prevention safety principles [1]. Occupational accidents refer to accidents that occur during work in the workplace and result in death or injuries [2]. The daily cost of these accidents is so high that the economic cost of this poor performance of occupational health is estimated to be 4% of the global gross domestic product per year [3]. Since any illness or any premature death is considered, a cost based on the safety economy principles, it is very important to assess its cost using a monetary scale [4]. The premature death of workers due to occupational accidents leads to the waste of human resources. Maintaining the health of the community and promoting it is one of the duties of governments. Maintaining and promoting the health of the workforce can have more positive economic impacts on society [5]. Hence, the observance of occupational safety and workplace health is one of the aspects of government intervention in the labor market [6]. For this reason, economic issues have found a special place in the investigation of occupational accidents and injuries. One of the benefits of the economics of safety to occupational accidents is that it determines the damages incurred and estimates the potential damages that may occur [7]. Numerous approaches have been used so far for the improvement of the health and safety status of organizations, each having its special results. The findings suggest that the use of a system approach in various areas not only helps integrate the activities but also results in efficiency and effectiveness and increased operational productivity.

Health and safety management systems are a set of tools for quantifying, analyzing, interacting, and even integrating the information management systems of companies [8]. These systems are a set of designed activities aimed at preventing injuries, accidents, diseases, mutilation and other accidents in the workplace [8] as well as the development of the internal structures of the institution to increase the efficiency of the cycle operation of the collection [9]. Management accounting will help managers through the measurement, analysis, and reporting of financial and non-financial information for decision-making about how to achieve the goals of the organization. Management accounting measures and reports information with an emphasis on intra-organizational users in order to help the managers of different levels execute the approved goals [10]. One of the identified problems in relation to the health and safety management system is the assessment of the effectiveness of the organization's safety system and its implementation throughout the organization. Indices used by performance appraisal tools are sometimes regarded as a regulatory tool for managers' work, preventing them from being executed by managers. Therefore, more effort should be made to familiarize managers with the health and safety management system and its performance measurement tools

It is very important to examine the lost value due to accidents and the value obtained from accident prevention from the perspective of management accounting. One of the investment problems in the area of safety is that the calculation of the monetary value of its benefits is very difficult, although the cost of investment in this area is well defined.

To motivate managers to invest in safety, it is important to provide the overall health and safety costs transparently so that they can be included in the decision making more confidently [13]. It should be noted, however, that this is rarely examined because it is time-consuming and includes difficult processes [14].

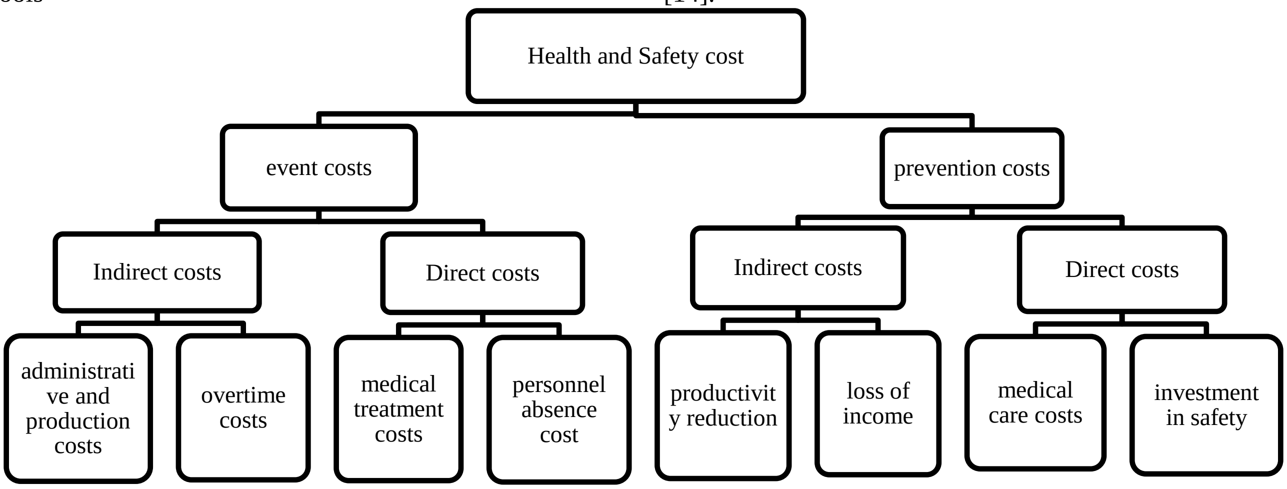

Fig1: prevention costs and event cost

Many definitions have been presented for safety in the workplace. In the research, the concept of safety is considered to be equal to "safety value". "Safety value" is defined as follows: "Safety value at the workplace, the ability of the company or company manager to manage operations in order to maintain economic, social and environmental health". It is very important to focus on cost engineering principles in the area of workplace safety and to accurately calculate its cost based on the cost-benefit principle because specialized and skilled human resources are one of the most valuable resources of each organization and it is of great importance to create a safe and proper work environment [11].

Holding more realistic tenders, more customer profitability, and optimal calculation of projects costs are among the results of the collection and analysis of the financial data related to safety activities with more accurate evaluation of cost calculations [10].

The most common methods for calculating safety in management accounting are [12]:

A) Calculation of the cost
B) Estimation of the cost of each damage
C) Calculation of the total costs incurred due to accidents

There are several classifications for health and safety. One of its simplest classifications is its division into prevention costs and event costs. Each of these costs is divided into direct and indirect costs, as shown in Fig.1. It should be noted that indirect costs are typically greater than direct ones [10].

Another study conducted by Impgaard and Rikhardsson divided accident costs into the following six categories: [15]

1) The absence of damaged personnel (such as the cost of treatment for a patient and the payment of its supplementary expenses)
2) Communications (such as formal communication between employees and organization management, and communication among staff)
3) Administrative costs (such as managing salary and wages and administering safety and health statute and reporting requirements, follow-up activities and meetings)
4) Prevention plans (such as purchasing machinery and training plans)
5) Disruptions in operations (such as alternative training, loss of income, overtime, and

productivity reductions)
6) Others (such as encouragement and punishment)

In generic, it can be introduced that direct costs are far more easily identifiable than indirect costs (that cannot be insured) and can be readily calculated by financial accounting. It should be noted that the identification of indirect costs is far more complicated and companies often do pay much attention to such unknown costs [16].

One of the economic indices that affect occupational accidents is productivity, and doing activities to reduce accidents can simultaneously increase productivity. Countries in the world have been struggling in recent years to increase their share of the global market and global trade, and they have to increase their competitiveness in order to achieve this. This will only be possible through productivity improvement. This is why achieving economic growth through productivity improvement is nowadays considered one of the most important economic goals of countries [17]. Changes in productivity are one of the important factors in explaining the cost-benefit factor, and a safety action is not justifiable regardless of its impact on productivity. Therefore, management accounting focuses on is a large agent in the management decision making for job safety, and it can provide useful information for the organization especially when the organization invests in the safety sector. A number of studies that have been carried out in this area are mentioned below.

Tappura *et al*. [10] reviewed the current management accountancy techniques for safety issues in other papers and studies. These methods contain the balanced scorecard approach, the repayment course, the return on investment rate, and the profit/cost proportion.

Brief *et al*. [18] examined the impact of occupational health and safety on business performance through the use of a balanced scorecard approach. They provided a link between health-related issues and key performance factors (quality, productivity, cost reduction, and absence from work).

Ibarrondo-Dávila *et al.* [19] conducted a study in which they examined the feebleness of present managerial accountancy systems concerning the preparation of organized data at the expense of actions to guarantee health and safety in the workplace. The results of their study revealed that health and safety expenses are basic and subsist hidden to the corporation to a lots great grade (rather than 90%), because the object that arranges this expense are interspersed inside another accountancy entrance, hence extant anonymous on the revenue manifest.

Gunarathne *et al*. [20] sought to recognize the yield of the safety check and accountancy, constitute social sustainability management in answer to diverse stakeholders' requirements and anticipation in the mining part establish on semi-structured interviews and on-place evaluations. The results showed that safety accountancy is an emergent thought in accountancy management and a set of accountancy devices and its appeal can be used to patronage collective decision-making on health and safety issues in the structure.

Christensen *et al*. [21] conducted research entitled "The Real Effects of Mandated Information on Social Responsibility in Financial Reports: Evidence from Mine- Safety Records", in which they inspect the actual impacts of compulsory disclosures on social liability, who need SEC-registered mine owners to locate their mine -safety records in their financial informs. They documented that containing a safety dossier in financial informs reduces mining-relevant relation and damages by 11% and 13%, relatively, and decrease labor efficiency by nearly 0.9%. Overall, their results illustrated that containing, data on social liability in financial informs can give economically notable actual possessions - even if than data disclosed elsewhere.

Many studies have been carried out to investigate the costs of accidents and their impact on productivity, and actual cost has often been used in these studies for calculation of the expenses of safety and health into the workplace, and generally, the expense of each harm or the actual expense of the total accidents has been calculated. Some of these studies have investigated human costs resulting from occupational accidents which have led to death, or have dealt with this important topic using methods such as the balanced scorecard, repayment period and cost-benefit analysis, but it should be noted that the relationship between the criteria affecting the safety value and its impact on productivity is very complex, and one criterion usually has an impact on other criteria. The evaluation and analysis of alternatives under various and complex conditions, especially in industrial areas which are affected by multiple criteria and varied alternatives, require the use of quantitative techniques and decision math models. Although different mathematical decision techniques are available to help the decision-making process, these techniques are not very popular due to their limited time and inherent complexity. Therefore, it is necessary to use methods that can examine several different criteria simultaneously in planning [22]. Therefore, we present in the present study a different model for improving the safety value using the multi-criteria decision-making technique in a fuzzy environment.

This research is organized into five sections. After the introduction, the second section deals with the literature review. The general framework of the pattern and the research method is introduced in the third section. Section 4 deals with the analysis and interpretation of the data, and finally, the conclusions and suggestions are presented in the fifth section.

MATERIALS AND METHODS

The Fuzzy Set opinion was first suggested by Professor Lotfi Zadeh. The Fuzzy Set Theory is used for conditions of uncertainty. This theory expresses many of the obscure and vague concepts and terms in mathematical language, and makes it easy to make decisions in conditions of uncertainty [23]. According to this theory, $\widetilde{A} = \{(x, \mu_{\widetilde{A}}(x)) | x \in X\}$ is a fuzzy set where x accepts the real values of the member of the R set and its membership function is $\mu_{\widetilde{A}}(x) : \rightarrow [0,1]$

The most common fuzzy numbers are triangular and trapezoidal fuzzy numbers. Triangular fuzzy numbers have been used in this study for the sake of its simpler calculations. A triangular fuzzy A number with a linear piecewise membership function μA is defined as Equation (1) and is shown in Fig. 2 as ordered triad (l, m, u) as [24].

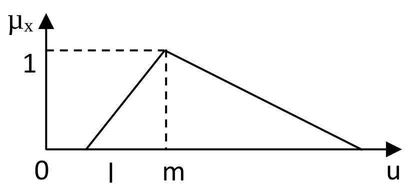

Fig2: Triangular fuzzy number

If $\widetilde{A}$ = (l1, m1, u1) and $\widetilde{B}$ = (l2, m2, u2) are two triangular fuzzy numbers, the distance function d ($\widetilde{A}$, $\widetilde{B}$) is defined as Equation (2) [25]:

If k is a fixed number and $\widetilde{A}$, $\widetilde{B}$ are two triangular numbers, then the main algebraic operations are described as equations 3-9 [25]:

(3) Summation of two triangular fuzzy numbers

$$\widetilde{A}(+)\widetilde{B} = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad l_1 \geq 0,\ l_2 \geq 0$$

(4) Multiplication of two triangular fuzzy numbers

$$\widetilde{A}(\times)\widetilde{B} = (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2) \quad l_1 \geq 0,\ l_2 \geq 0$$

(5) Subtraction of two triangular fuzzy numbers

$$\widetilde{A}(-)\widetilde{B} = (l_1 - l_2, m_1 - m_2, u_1 - u_2) \quad l_1 \geq 0,\ l_2 \geq 0$$

(6) Division two triangular fuzzy numbers

$$\widetilde{A}(\div)\widetilde{B} = (l_1 \div l_2, m_1 \div m_2, u_1 \div u_2) \quad l_1 \geq 0,\ l_2 \geq 0$$

(7) The inverse of a triangular fuzzy number

$$\widetilde{A}^{-1} = (\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}) \geq 0$$

(8) Multiplication of a triangular fuzzy number by a fixed number

$$k \times \widetilde{A} = (k \times l_1, k \times m_1, k \times u_1) \quad l_1 \geq 0,\ k \geq 0$$

(9) Division a triangular fuzzy number into a fixed number

$$\frac{\widetilde{A}}{k} = (\frac{l_1}{k}, \frac{m_1}{k}, \frac{u_1}{k}) \quad l_1 \geq 0\ ,\ k \geq 0$$

Fuzzy TOPSIS Method [1]

TOPSIS is an MCDM, first suggested by Hwang and Yoon in 1981 [26] and further developed by Yoon in 1987 and Hwang *et al*. in 1993.[۲۸]

The Fuzzy TOPSIS method was suggested by Chen to solve MCDM difficulty under uncertainty conditions [29], and the use of fuzzy logic in the TOPSIS approach has been developed in various sciences [30-33].

Given the fact that human judgment modelling is unclassified and unclear, linguistic variables, which are more realistic and tangible, have been used instead of numerical evaluation in the development of the Fuzzy TOPSIS method in order to rank the alternatives and weight the criteria [34].

Many methods are used to evaluate the weights of the criteria and rank the alternatives [35, 36, 37, and 38]. One of these methods is direct allocation or pairwise comparisons [29, 39]. Linguistic variables and direct weighing methods have been used in the present study, and the decision-makers (D = 1,2 ..., K) have used linguistic variables and corresponding triangular fuzzy numbers proposed by Chen [29] for weighting, as shown in Tables 1 and 2.

Table1: Linguistic variables according to the weight of each criterion

Linguistic variables	Triangular fuzzy numbers
Very low (VL)	(0.0, .00, 0.1)
Low (L)	(0.0, 0.1, 0.3)
Medium low (ML)	(0.1, 0.3, 0.5)
Medium (M)	(0.3, 0.5, 0.7)
Medium high (MH)	(0.5, 0.7, 0.9)
High (H)	(0.7, 0.9, 1.0)
Very high (VH)	(0.9, 1.0, 1.0)

Table2: Linguistic variables for the ratings

Linguistic variables	Triangular fuzzy numbers
Very poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Medium poor (MP)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very good (VG)	(9, 10, 10)

[1] Technique for Order Preference by Similarity to Ideal Solution

The Fuzzy TOPSIS technique is executed in the following steps [29]:
The decision-making group includes K members and the weights of the criteria are summed up and the alternatives are ranked according to evaluations 11 and 12. $\tilde{w}_j$ represents the weight of the j[th] criterion.

$$\tilde{W}_j = \frac{1}{K}\left[\tilde{W}_J^1 + \tilde{W}_J^2,\ldots\ldots,\tilde{W}_j^k\right] \quad (11)$$

$$\tilde{x}_{ij} = \frac{1}{k}\left[\tilde{x}_{ij}^1 + \tilde{x}_{ij}^2 + \ldots. + \tilde{x}_{ij}^{k}\right]$$

In this matrix (D), $\tilde{x}_{ij}$ shows the rank of the j[th] alternative (i = 1,2 ..,., m) based on the j[th] criterion (j = 1, 2 ..,., n), which is based on linguistic variables (Equation 13).

$$\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}) \quad (13)$$

Step I: Equation 14 shows the decision matrix of the criteria and alternatives:

$$\tilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & . & . & . & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & . & . & . & \tilde{x}_{2n} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ \tilde{x}_{m1} & \tilde{x}_{m2} & . & . & . & \tilde{x}_{mn} \end{bmatrix} \quad (14)$$

$$\tilde{W} = \left[\tilde{W}_1, \tilde{W}_2, \ldots\ldots, \tilde{W}_n\right] \quad (15)$$

Step II: At this stage, the fuzzy decision matrix should be converted to a comparable scale and then normalized. Several methods have been proposed for such normalization, and here we will use the linear normalization method proposed by Chen. So, we will use equations 16 and 17 to normalize the profit and cost criteria.

$$\tilde{R} = \left[\tilde{r}_{ij}\right]_{m\times n} \quad (16)$$

$$\tilde{r}ij = \begin{cases} \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right), & j \in B \quad , c_j^* = \max c_{ij} \; if \; j \in B \\ \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right), & j \in C \quad , a_j^- = \min a_{ij} \; if \; i \in c \end{cases} \quad (17)$$

Step III: The fuzzy weighted normal matrix is obtained from Equation 18.

$$\tilde{V} = \left[\tilde{v}_{ij}\right]_{m\times n}, \quad i = 1,2,\ldots,m, \quad j = 1,2,\ldots.,n \quad (18)$$

If $\tilde{v}_{ij} = \tilde{r}_{ij} . \tilde{w}_j$

Step IV: The positive ideal solutions (FPIS, A +) and the negative ideal (FNIS, A-) solutions are determined based on equations 19 and 20.

$$A^* = \left(\tilde{v}_1^{\,*}, \tilde{v}_2^{\,*}, \ldots., \tilde{v}_n^{\,*}\right) \quad (19)$$

$$A^- = \left(\tilde{v}_1^{\,-}, \tilde{v}_2^{\,-}, \ldots., \tilde{v}_n^{\,-}\right) \quad (20) \; (21)$$

Here, according to Chen Fuzzy positive fuzzy ideal and negative fuzzy ideal, $\tilde{v}_j^-$ = (0,0,0) a $\tilde{v}_j^*$ (12) =(1,1,1,).

Step V: The distance between the i[th] alternative, or the positive ideal (A [+]) and negative ideal (A[-]) are obtained based on equations 21 and 22, and the distance between the two triangular fuzzy numbers is calculated using Equation (2)

$$d_i^{\,*} = \left\{\sum_{j=1}^{n} d \;\; \left(\tilde{v}_{ij}, \tilde{v}_j^*\right)\right\} \quad i = 1,2,\ldots,m,\; j = 1,2,\ldots,n$$

$$d_i^{\,-} = \left\{\sum_{j=1}^{n} d \;\; \left(\tilde{v}_{ij}, \tilde{v}_j^-\right)\right\} \quad i = 1,2,\ldots,m,\; j = 1,2,\ldots,n \quad (22)$$

Step VI: The relative closeness coefficient of the i[th] alternative (CC_i) is computed using Equation 23.

$$i = 1,2,\ldots,m \;\; 0 \le cl_{i+} < 1 \;\; CC_i = \frac{d_i^-}{\left(d_i^* + d_i^-\right)}, \quad i = 1,2,\ldots,m \quad (23)$$

Considering the closeness coefficient of CC_i, the ranking of alternatives is arranged in going down the order. The foremost alternative is the nearest alternative to FPIS and the farthermost alternative to FNIS. In other words, the greater the relative closeness rate, the more ideal its corresponding alternative will be.

RESULTS

This is a case study on a small-scale power plant (Distributed Generation (DG_2)) in Mazandaran province (Iran). The aim of this perusal is to provide a pattern for improving the safety value by using productivity indices in a fuzzy environment, the results of which will help meet the information needs of managers for decision making. Indices affecting health and safety include many quantitative and qualitative indices….

The relationship between these indices or criteria is complex and usually affects other criteria. Therefore, it is not easy to build a model and find the best solution using independent criteria. Therefore, using multi-criteria decision-making techniques (MCDM) will be useful. Multivariate decision making is a collection of methods and procedures that try to perform an analysis on a number of quantitative or qualitative, often incompatible indices, in order to select an alternative. The Fuzzy TOPSIS technique has been used in this etude to solve the decision-making difficulty. The proposed model, like other decision-making methods, consists of three levels of goal, criteria, and alternatives. As stated earlier, this study aims to improve the safety value and the criteria used in this study are criteria that affect productivity in the manufacturing industry, which will be presented below. Alternatives, which are a solution to achieve the goal of this study, have been determined by studies conducted in the research literature section, especially in the references (10 and 15), and via numerous interviews with experts and brainstorm sessions. These alternatives include creating executive safety regulations in administrative and production sectors (A_1), investing in medical care and safety equipment (A_2), holding classes and training courses (A_3), and purchasing new machinery, equipment and technologies (A_4).

In order to select the criteria to be studied, research should be stated, Since the industrialization of the world and the exploitation of new and modern technologies and industrial automation in production, the topic of optimal use of the factors of production and increase in the output of products has received much attention and focus, and productivity indices have been defined and evaluated for a comparison of the organizations and industries with one another and in order to determine the success of each one in terms of productivity [40].

Productivity means the degree of effective use of each of the factors of production. [41] In other words, it means the ratio between all tangible outputs to tangible inputs [42]. Thus, productivity can be defined as the ratio of the production of goods and services, or a set of goods and services (outputs), to one or more data (inputs) that affect the production of those goods and services. Inputs may include land, manpower, capital, energy, etc., and output means the total value of goods and services that have been achieved over a given period in an industrial unit [43].

Today, various criteria have been identified and introduced as indices affecting the productivity of manufacturing industries. Among these criteria are labor, capital and other inputs such as energy and raw materials [44]. One of the most complete studies concerning productivity is the study carried out by Lee & Leem (2016). These researchers reviewed articles on the productivity of manufacturing industries from 1890 to 2009. Having reviewed 11237 articles, they identified 95 keywords and classified them into nine indices. These indices included automation, quality, process, information, innovation, cost, workforce, energy and the environment [45]. Other studies have been carried out in the area of productivity of manufacturing industries to examine the important indices affecting the productivity of manufacturing industries, such as productivity of workforce [46, 47, 48], energy productivity [49, 50], and capital productivity [51, 52, 53, 54].

Therefore, considering the previous studies and surveys performed with experts, the most effective productivity criteria for the present research include labor productivity (LP), energy productivity (EP) and capital productivity (CP), as described in Table 3.

Table 3: Definition of Productivity Indices

Productivity indices	Definition	code
Labor productivity	The ratio of value-added to the number of employees [47]	LP
Energy productivity	The ratio of value-added to the energy value [49]	EP
Capital productivity	The ratio of value-added to the capital cost [47]	CP

Discussion

As presented in the Materials and Methods section, the TOPSIS method has six steps, which are as follows in the process of this case study. After formulating the hierarchy of the proposed model (Fig.3), the criteria were weighted and the alternatives were ranked by decision-makers (D1, D2 & D3) including the operation manager and supervisors of the team of operators and maintenance team based on the linguistic variables presented in Tables 1 and 2, the results of which are presented in Tables 4 and 5.

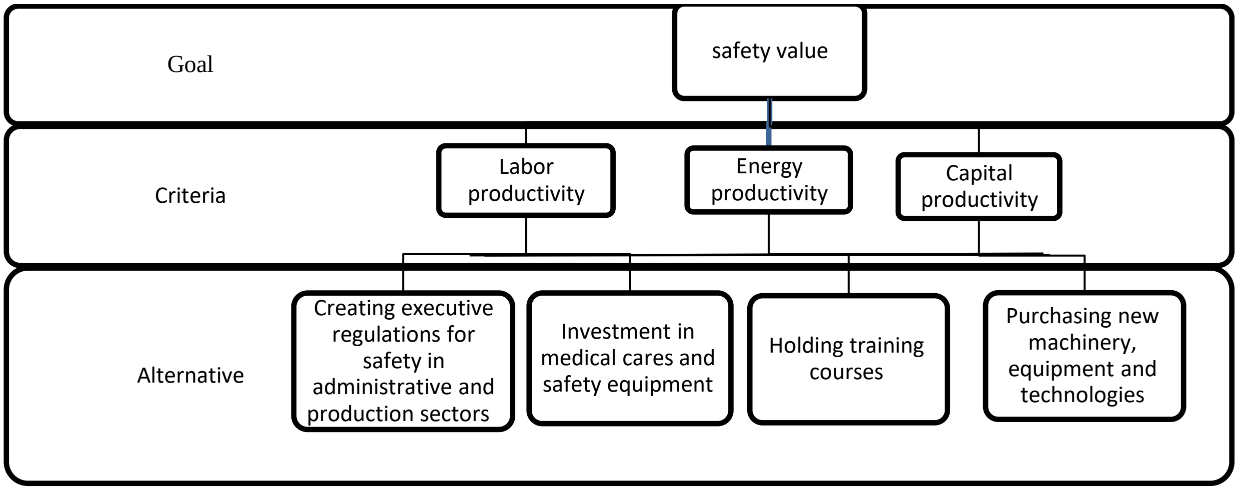

Fig. 3: Hierarchical analysis diagram

Table 4: The importance weight of the criteria

criteria	D_1	D_2	D_3
Labor productivity	ML	M	ML
Energy productivity	MH	M	M
Capital productivity	VH	H	H

Table 5: The Alternative ratings according to the criteria under consideration

Criteria	Alternative	D_1	D_2	D_3
Labor productivity	A_1	F	F	F
	A_2	MG	F	F
	A_3	G	MG	F
	A_4	F	F	F
Energy productivity	A_1	VG	G	VG
	A_2	MG	MG	G
	A_3	G	G	MG
	A_4	G	G	F
Capital productivity	A_1	VG	VG	G
	A_2	G	G	G
	A_3	VG	VG	VG
	A_4	VG	G	MG

In the first stage, the linguistic variables obtained from the opinions of experts were converted into triangular fuzzy numbers and presented in Table 6. In the next step, according to Equation 17, the normal decision-making matrix is calculated (Table 7). In the third stride, after normalization, the weighted normal matrix, which is obtained by fuzzy multiplication of the normal matrix by the weight of the criteria, is calculated based on Equation 18, as presented in Table 8. Now, in the fourth step, using equations 19 and 20, the positive ideal and negative ideal numerical values were calculated, and then in the fifth step, Equation 2 was used to calculate the distance between two fuzzy numbers (d). Finally, in the sixth step, the relative proximity of each option to the ideal solution (Equation 23) was determined and presented in descending order in Table 9.

Table 6: The fuzzy decision matrix and fuzzy weights of four alternatives

Code	LP	EP	CP
A_1	(3.00, 5.00,7.00)	(8.33, 9.67, 10.0)	(8.33, 9.67, 10.0)
A_2	(3.67, 5.67, 7.67)	(5.67, 7.67, 9.33)	(7.00, 9.00, 10.0)
A_3	(5.00, 7.00, 8.67)	(6.33, 8.33, 9.67)	(9.00, 10.0, 10.0)
A_4	(8.33, 9.67, 10.0)	(5.67, 7.67, 9.00)	(7.00, 8.67, 9.67)
Weight of criteria	(0.17, 0.37, 0.57)	(0.37, 0.57, 0.77)	(0.77, 0.93, 1.00)

Table 7: The fuzzy normalized decision matrix

Code	LP	EP	CP
A_1	(0.30, 0.50, 0.70)	(0.83, 0.97, 1.00)	(0.83, 0.97, 1.00)
A_2	(0.37, 0.57, 0.77)	(0.57, 0.77, 0.93)	(0.70, 0.90, 1.00)
A_3	(0.50, 0.70, 0.87)	(0.63, 0.83, 0.97)	(0.90, 1.00, 1.00)
A_4	(0.83, 0.97, 1.00)	(0.57, 0.77, 0. 90)	(0.80, 0.87, 0.97)

Table 8: The fuzzy weighted normalized decision matrix

Code	LP	EP	CP
A_1	(0.05, 0.18, 0.40)	(0.31, 0.٥٥, 0.77)	(0.64, 0.90, 1.00)
A_2	(0.06, 0.21, 0.43)	(0.21, 0.43, 0.72)	(0.54, 0.84, 1.00)
A_3	(0.08, 0.26, 0.49)	(0.23, 0.47, 0.74)	(0.69, 0.93, 1.00)
A_4	(0.14, 0.35, 0.57)	(0.21, 0.43, 0.69)	(0.54, 0.90, 1.00)

Table 9: The distance measurement, closeness coefficient and rank order of alternatives

Code	Alternative	CC_i	d^+	d^-	Rank
A_1	Creating executive regulations for safety in administrative and production sectors	0/512	0/894	0/942	2
A_2	Investment in medical care and safety equipment	0/462	1/025	0/880	4
A_3	Holding training courses	0/531	0/870	0/988	1
A_4	Purchasing new machinery, equipment and technologies	0/502	0/943	0/951	3

The results of analysis of experts' views using the proposed model to improve the safety value by use of productivity indices showed that holding classes and training courses (0.531) is the most important solution for improving safety value in manufacturing industries such as power plants. The creation of executive regulations for safety in administrative and manufacturing sectors (0.512) was ranked second, the purchase of new machinery, equipment and technologies (0.502) was ranked third, and investment in medical care and safety equipment (0.650) was ranked fourth.

Considering what has been discussed, safety, measurement of the cost of safety and management of the cost and safety value are of particular importance. As Argilés-Bosch *et al.* (2014) [41] have argued, companies should consider the resources and techniques of management accounting for the proper assessment of the economic consequences of occupational accidents. In addition, this information can help the company's social image and enhance its value by providing occupational safety and health and providing relevant information for stakeholders. Management accounting can play a significant role as an information system for management by providing appropriate reports systematically in arrangement to backing the decision-making procedure in the extent of work safety and health [10, 41]. Knowledge of the essence and dimensions of safety costs is really important for risk management in corporations [19].

Studies in a country like Turkey showed that, despite the creation of new changes in accordance with the EU standards and the high costs of safety, no significant reduction has occurred in the number of occupational incidents so far. Examining the hidden factors of these shortcomings shows that a large part of this issue results from the lack of real investment in education, which has the greatest impact among other safe investments. Even when all requirements such as medical care, safety equipment and technology and machinery is supplied, the desirable level of safety culture cannot be achieved without allocating enough time to training. Further important facture guaranteeing the safety of civilization is the adoption of regulations such as the promotion and encouragement system [56]. As with education, a healthy safety civilization It can't be achieved without suitable incentive and promotional programs. [57]. With all of these points and findings in mind, it can be assumed that neither mandatory safety investitures such as investiture in safety rig and health surveillance nor freewill investiture in technology, research and development, can by itself guarantee the development of an appropriate safety civilization; Indeed, it is actual investments for the teaching and suitable execution of incentive and promotional programs that chip into the expansion of a safety civilization.

CONCLUSION

Safety at work is linked to one of the most valuable resources of the organization, which doubles its importance because human resources and intellectual capital is considered one of the most influential factors in creating value in an organization.

Safety improvement may also contain other affirmative effects including better jobholder onus. Non-financial interests, such as safety and Efficiency betterment, should be considered along with financial benefits so that their importance can be highlighted. The roles of safety in productivity include optimal use of material resources, human resources, as well as improving quality and reducing the production costs, reducing waste, job satisfaction and reducing occupational accidents. However, it is very difficult to verify its causal relationship. In addition, the excellent and accessibility of health-related information is still a primary hindrance to the connection of professional health and safety and business act. Adapting safety viewpoints and business strategies when promoting safety and investments leads to value creation for the organization. To assess the profitability of the safest investments, many concepts and methods need to be considered from the perspective of management accounting.

ETHICAL ISSUES

All the unique sentences, no theft is plagiarism.

COMPETING OF INTEREST

Authors have no conflict of interest.

AUTHORS' CONTRIBUTIONS

All authors equally helped to write this manuscript.

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