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A Decision Support Model for Prioritization of Safety Five Stars System Elements on Saudi Electricity Company using Integrated AHP and TOPSIS Approach

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Abstract: Occupation Health and Safety (OHS) become as main parts of every company as the safety of people, machines, equipment and facilities become its goal. In 2015 G Saudi Electricity Company decided to use the Five Star Safety and Health Management System on all its facility around the Kingdom. It is the main purpose for this system to minimize number of accident / injuries and in consists of that it looks for 5 stars rating. However, the Five Stars Safety and Health Managements System have 73 elements to be implemented and evaluated which need a lot of resources, this research aim to identify the highest important elements out 73 elements from Five Stars Safety and Health Managements System that highly affect the company evaluation as well as lead to many accidents. The objective of the current research is to present a prioritization model based on Eight criteria using an integrated Delphi, AHP and TOPSIS approach. The decision main criteria as pairwise comparisons were decided by a group of experts through a Delphi methodology. In addition, the weights of the main was determined using AHP method. the final ranking results have been compared with the last 5 years Evaluations and the root cause for accidents.

Keywords: Multi Criteria Decision Making, MCDM, AHP, TOPSIS, Safety Prioritization, and 5-Stars Safety

I. INTRODUCTION

Safety of people, machines, equipment, and facilities is a goal for every company. Were the implementations of safety can minimize the number of accidents and injuries. Moreover, the consequences from accidents financial costs such as machine damage, broke, fire or death can be compensating or replaced but the human life cannot be compensated. Further, accidents can cause a permanent injury for workers which will end their careers. Additionally, high number of accidents will effect on the company, costumers, and clines by stopping works, delaying providing services, or blackout the services. Also, it will affect the company safety reputation which will increase the insurance costs and decrease future project with clients [1-5].

In 2015 G Saudi Electricity Company decided to use the Five Star Safety and Health Management System on all of its facility around the Kingdom. However, main porpose for this system it to minimize number of accident / injuries and in consists of that it looks for 5 stars rating. Moreover, due to it limited resources and budget the company could not achieve either zero accidents neither 5 stars rating because of the Five Stars Safety and Health Managements System have 73 elements to be implemented and evaluated [1 & 6].

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The objective of this research is to identify the highest important elements out 73 elements from Five Stars Safety and Health Managements System that highly affect the company evaluation as well as lead to many accidents.

II. LITERATURE REVIEW

A Health and Safety Management System becomes essential part of every organization around the world. It covers all process that insure the health and safety of workers and workplace. In addition, it plans to prevent or minimize accidents and injuries. Additionally, its cover the procedure, practices and to maintain organization occupational safety and health policy [2].

The Five Star Safety and Health Management System is one of Many of Health and Safety Management Systems that used worldwide. The main categories are Premises and Housekeeping, Electrical, Mechanical and Personal Safeguarding, Fire Protection and Prevention, Accident Recording and Investigations, and Health and Safety Organization. Moreover, each of main element contain many sub elements. However, The Five Star Safety and Health Management System Contains 73 elements distributed among the 5 main elements [3].

The first main element of The Five Star Safety and Health Management System is Premises and Housekeeping which include procedure to Structures and Facilities, Ventilation, Pollution, Housekeeping, Storage and Scrap. On the other hand, the Electrical, Mechanical and Personal Safeguarding include the Machine Guarding, Ladders, Stairs and Walkways, Lifting Gear, Hazardous Substances control, Motorized equipment, Portable Electrical equipment, General Electrical installations, Tools, Ergonomics, Protective equipment, Clothing and Footwear, Safety Signs. Moreover, the third element is Fire Protection and Prevention which include Means of evacuation, Fire Extinguishing equipment location and usage, Maintenance of equipment, Storage of Flammable or Explosive Material, Alarm Systems, Fire Drills, Security Systems, Emergency Planning and Response. In addition, the fourth element is Accident Recording and Investigations which shows all injury/Accidents record, Incident reporting and investigation, Damage reporting and investigation, Rehabilitation practices, Incident statistics, Insurance of apportioning of costs, and Incident recall [4]. Finally, the last elements is Health and Safety Organization which is focus on Senior Executive Designated, Responsible for safety, Persons made responsible for safety/occupational hygiene co-ordination, Safety committees, First Aid, Safety Promotion, Annual Report - Loss Control Achievements, Induction and Job Safety Training, Medical Examinations, Stress Control, Biological Hazards, Risk Assessment, Plant Inspections by Safety Representatives, Employment Practices, Internal Safety audits, Written Safe Work Procedures, Planned Job Observation, Off-the-job Safety, Safety Policy, Management involvement and Commitment & Leadership [3].

There are many of statistical and non-statistical decision-making techniques have been exposed to model complex business or engineering processes. one of the commonly range method that have been become as popular technique is Multiple-criteria decision-making (MCDM) [5]. Many methods have been proposed for solving MCDM problems [6], such as Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) Preference Ranking Organization Method (PROMETHEE), and many others [4]. MCDM is usually used to solve various decision making, ranking and selection problems such as Selection of (process, procedure, supplier, location, technology, material) and to evaluate competitiveness or to rank the elements.

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Table 1: 5-Stars Safety and Health Management System Elements

Premises & Housekeeping	Mechanical, Electrical & Personnel Safeguarding	Fire Protection and Prevention Protection	Accident Recording and Investigation	Safety Organization
1. Buildings and Floors 2. Good Lighting: Natural and Artificial 3. Ventilation: Natural and Artificial 4. Plant Hygiene Facilities 5. Pollution: Air, Ground & Water 6. Aisles and Storage Demarcated 7. Stacking and Storage 8. Housekeeping 9. Scrap and Refuse Bins Removal System 10. Color Coding: Plant & Pipelines	1. Machine/Hazardous Equipment Guarding 2. Lock-Out Tag-Out 3. Labeling of Switches, Isolators and Valves 4. Ladders, Stairs, Walkways and Scaffolding 5. Lifting Gear and Records 6. Compressed Gas Cylinders Pressure Vessels and Records 7. Hazardous Substance Control 8. Risk assessment 9. Motorized Equipment - Checklist, licensing 10. Portable Electrical Equipment 11. Electrical Equipment Maintenance 12. General Electrical Installations and Flameproof 13. Hand Tools 14. Ergonomics 15. Head Protection 16. Eye and Face Protection 17. Footwear 18. Protective Clothing 19. Respiratory Equipment 20. Hearing Conservation 21. Safety Harness 22. Hand Protection 23. Control of Usage 24. Notices and Signs Electrical, Mechanical, Protective Equipment	1) Fire Extinguishing Equipment Systems 2) Locations marked, Floor Clear 3) Maintenance of Fire Equipment 4) Storage of Flammable and Explosive Material 5) Alarm System 6) Fire Drill and Emergency Evacuation 7) Security Roles for Safety 8) Emergency Planning 9) Fire Coordinator Appointment	1) Occupation Injury/Disease Record 2) Internal Accident Reporting 3) Occupational Injury Disease Statistics 4) Property Damage and Business 5) Accident Statistics Kept 6) Insurance Apportioning of Costs 7) Accident Near Miss Recall	1) Managers Designated as Responsible for Safety and Health 2) Safety and Occupational Hygiene Coordination 3) 5-Star Safety Representatives 4) Safety Committees 5) Communication Systems 6) First Aid Responder and Facilities 7) First Aid Training 8) Publicity, Bulletins, Newsletters, Safety Films 9) 5-Star Safety Board 10) Suggestion Scheme 11) Safety Reference Library 12) Annual Report Safety and Health Achievements 13) Orientation and Job Safety Training 14) Approved Safety Training Courses 15) Medical Examinations 16) Workplace Inspections 17) Safety Performance Indicators 18) Safety Specifications 19) Written Safe Work 20) Planned Job Observations 21) Work Permits 22) Off-The-Job-Safety 23) Safety Policy

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III. RESEARCH METHODOLOGY

To achieve study objective, the following steps were followed:

1) Identifying the 5-Star domains and elements used for evaluation.
2) Identifying the criteria for analyzing the effect of 5-Star elements.
3) Determination of the weights and priority vector of the criteria using Delphi approach and AHP method.
4) Using TOPSIS methodology to rank the elements.
5) Data collection to compare the proposed approach with the actual safety performance data (e.g., accident records and 5-Star auditing results).

1) Identifying the 5-Star domains and elements used for evaluation

The data collected from the Health and Safety Coordinator of Saudi Electricity Transmission Projects on western area. The data cover last five years 2017- 2021 G that were implemented on projects. In addition, multiple meeting was held to insure the precise and accuracy of the data. However, collected reports have indicated that 73 elements were evaluated for each project and the average of all will be use in this study.

The collected data of 5-Stars safety and Health shows that the elements were distributed on 5 main topics as shown on Table 1

2) Identify The Criteria for Analyzing The Effect of 5-Star Elements.

To use the Multi Criteria Decision Analysis tools to evaluate the 5-Stars elements (73 Elements) on our study below criteria were used. The selected criteria will focus on many aspects such as Cost, Health, Time, Repetition, Training, accident, and authority.

Moreover, each criterion has been dividing into 5 levels as **(Very Low, Low, Moderate, High and Very High).**

A. Cost Impact

According to Saudi Electricity Company Procedure No: OHS-PR-02-03 that called (Hazard Identification and Risk Assessment) the cost impacts were estimate given in table 2.

B. Health and Safety Severity

According to Saudi Electricity Company Procedure No: OHS-PR-02-03 that called (Hazard Identification and Risk Assessment) the Health and Safety Impact were estimate in table 3.

Table 2: Cost Impact Level

Level	***Cost Impacts***
Very Low	Negligible cost, or accept as is
Low	Costs or loss SR10,000 – SR100,000
Moderate	Costs or loss SR100,000 –SR1M
High	Costs or c loss SR1M - SR10M.
Very High	Costs or loss SR10M or more

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Table 3: Health and Safety Severity Level

Level	***Health and Safety Impact***
Very Low	First Aid Case
Low	Medical Treatment Case
Moderate	Loss Time, Injury
High	Single Fatality, Loss of Quality-of-Life
Very High	Multiple Fatalities

C. Time Impact

According to Saudi Electricity Company Procedure No: OHS-PR-02-03 that called (Hazard Identification and Risk Assessment) the Time Impact was estimated as:

Table 4: Cost Impact Level

Level	***Time Impacts***
Very Low	No interruption to work
Low	Work interrupted
Moderate	Temporary site closure (less than a day)
High	Temporary site closure (more than a day)
Very High	Permanent site closure or eviction

D. Repetition

According to Saudi Electricity Company Procedure No: OHS-PR-02-03 that called (Hazard Identification and Risk Assessment) the repetition levels were estimated as:

Table 5: Repetition Level

Level	***Repetition***
Very Low	it is highly unlikely to occur within 20 years.
Low	could happen within 20 years.
Moderate	could happen within 10 years.
High	is likely to reoccur within 5 years.
Very High	more per year & is likely to reoccur within 1 year

E. Implementation Cost

According to Saudi Electricity Company Procedure No: OHS-PR-02-26 (Incident, Non-conformity Management) the accident levels were estimated as:

Table 6: Implementation Cost Level

Level	***Implementation Cost***
Very Low	Costs SR1 – SR1,000
Low	Costs SR1,000 – SR10,000
Moderate	Costs SR10,000 – SR30,000
High	Costs SR30,000 – SR50,000
Very High	Costs SR50,000 or more

F. Implementation Time

According to Saudi Electricity Company Procedure No: OHS-PR-02-03 that called (Hazard Identification and Risk Assessment) the Implementation Time were estimate as:

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Table 7: Implementation Time Level

Level	*Implementation Time*
Very Low	1 Day to 10 Days
Low	10 Days to 1 Month
Moderate	1 Month to 3 Months
High	3 Month to 6 Months
Very High	6 Month to 12 Months

G. Training

According to Saudi Electricity Company, training Matrix 28 training Programs are required which will take 38 days. Therefore, the levels of training were estimate as:

Table 8 Training Level

Level	*Training*
Very Low	Required 1 Day to 5 Days
Low	Required 5 Days to 10 Days
Moderate	Required 10 Days to 15 Days
High	Required 15 Days to 20 Days
Very High	Required 20 Days or More

H. Authority Level

According to Saudi Electricity Company Procedure No: OHS-PR-02-01 that called (Leadership, Responsibility and Accountability) the Authority Level were estimate as:

Table 9: Authority Level

Level	*Authority*
Very Low	Employees
Low	OHS Coordinator or Team Leaders, Line Supervisors, and Contract Holders
Moderate	Regional ISD Managers and OHS Advisors or Line Managers / Leaders
High	OHS Management Representative
Very High	Chief Executive Officer (CEO) or Executives, Vice-Presidents and Directors

3) Determination of the weights and priority vector of the criteria using Delphi approach and AHP method.

In this research Analytic Hierarchy Process (AHP) is used to prioritize the 5-Stars safety and health system elements [8]. However, AHP is analytical hierarchy method which used commonly to evaluate the weights of decision criteria. This method was developed in 1970 by Saaty [9]. As shown on criteria section above 8 decision criteria will be applied to the 73 elements of 5-Stars Safety and Health System. As recommended by Thomas L. Saaty [10] the initial step is to pair-wise comparisons of all criteria the weights of the criteria were evaluated by expert judgment of safety team on Saudi Electricity Company. The Saaty scale shown in table 10 was used to pair-wise comparisons.

The pair-wise comparisons between the criteria are constructed by Expert judgments between the Left Side Scale of C1 and Right-Side Scale C2, such as the C1 is Extremely important than C2 and is rated at 9, then C2 must be absolutely less important than C1 and is valued at 1/9. However, if the C3 have very strong importance than C1 then it will be rated as 7 which conclude that C1 have 1/7 rate with compared to C4. additionally, the criteria will be rated as 1 when both are the same or have equally importance. These pairwise comparisons are carried out for all factors as per table 11.

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Table 10: Saaty Scale

Intensity of Importance	***Definition***	***Explanation***
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Table 11: pairwise comparisons

Criteria	***Left side scale***									***Right side scale***								***Criteria***
C1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**C2**
C1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**C3**
C1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**C4**

After that to construct reciprocal matrix with consider n elements to be compared, $C_1 \ldots, C_n$ and denote the relative scale (priority or significance) of C_i with respect to C_j by a_{ij} and form a square matrix A=(a_{ij}) of with size of $n \times n$ with the constraints that $a_{ij} = \frac{1}{a_{ij}}$ or i ≠ j, and a_{ii} = 1 as follows:

$$A = (a_{ij})_{n\times n} = \begin{matrix} C_1 \\ C_2 \\ \vdots \\ C_n \end{matrix} \begin{bmatrix} a_{ii} & a_{ij} & \cdots & a_{in} \\ a_{ji} & a_{jj} & \cdots & a_{jn} \\ \vdots & \vdots & \vdots & \vdots \\ a_{ni} & a_{nj} & \cdots & a_{nn} \end{bmatrix} \quad (1)$$

The next step is to calculate the eigenvector, which we called the Relative Value Vector by standard methods Saaty method by "equation (1)" and apply it for all elements on the matrix A to construct the synthesized matrix.

$$a_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (2)$$

The weights of criteria are computed by "equation (2)":

$$w_i = \frac{\sum_{j=1}^{n} a_{ij}^{*}}{n} \quad (3)$$

After that we multiply the weight with Pairwise comparison matrix A for all Criteria to construct the new matrix which called eigenvectors matrix. After that eigenvalue is calculated for all criteria by "equation (4)".

$$AW = \lambda_{max} W \quad (4)$$

Then the maximum eigenvalue λ_{max} of *A* which is selected in order to calculate the consistency index (*CI*) for each matrix of order *n* can be obtained from "equation (5)". Also, to calculate the consistency ratio (*CR*) of the estimated vector which measure how consistent of the judgements have been relative to large samples of purely random judgements where *RI* is the random consistency index derived by Saaty for the corresponding value from large samples of matrices of purely random judgments using table 13

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$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (5)$$

$$CR = \frac{CI}{RI} \quad (6)$$

Finally, to check the judgments a comparison of CR as if the CR is in excess of 0.1 the judgements are unreliable, and the exercise is valueless and must be repeated.

Table 12 purely random judgments

Size of matrix	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

4) **Using TOPSIS methodology to rank the elements**.

To rank the 5-Stars Safety and Health Elements, one of the most useful analytical multi-criteria decision-making techniques will be used. This technique was developed in 1981 by Hwang and Yoon [11]and calls it a Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) [12]. The principle of this technique is that the selected (preferred) alternative is the one which is the closest to the positive ideal solution (PIS) and the further to the negative ideal solution (NIS). The positive ideal solution is formed as a combination of the best points of each criterion. The negative ideal solution is a combination of the worst points of each criterion.

The numerical data as weight of the criteria as calculated on pervious section will be used as input for this technique. As the objective of this study is to identify the highest important elements out 73 elements from Five Stars Safety and Health Managements System that highly affect the Saudi Electricity company evaluation as well as lead to many accidents.

The following steps are:

A. Create an evaluation matrix consisting of m alternatives and n criteria, with the intersection of each alternative and criteria given as C_{ij} we therefore have a matri $B = (B_{ij})_{n\times m}$

$$B = \begin{array}{c} \\ E_i \\ E_2 \\ \vdots \\ E_n \end{array} \begin{array}{c} \begin{array}{cccc} C_j & C_2 & \dots & C_m \end{array} \\ \begin{bmatrix} f_{11} & f_{12} & \dots & f_{1m} \\ f_{21} & f_{22} & \dots & f_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ f_{n1} & f_{n2} & \dots & f_{nm} \end{bmatrix} \end{array} \quad (7)$$

Here, Ei denotes the alternative Elements to be evaluated and i = 1, 2, …, n; Cj denotes the decision criteria and j = 1, 2, …, m; f_{ij} denotes the score of the i^{th} alternative (Element) with respect to the j^{th} decision criteria

B. calculate the normalized the decision matrix to R = $(R_{ij})_{n\times m}$ by using "equation (8)" for i = 1, 2, …, n and j = 1, 2, …, m.

$$r_{ij} = \frac{f_{ij}}{\sqrt{\sum_{j=1}^{m} f_{ij}^2}} \quad (8)$$

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C. Calculate the weighted normalized decision matrix W = $(W_{ij})_{n\times m}$ by using "equation (9)"

$$W_{ij} = w_j \times r_{ij} \quad (9)$$

D. Determine the worst alternative E_w and the best alternative E_B as per "equation (10)" and "equation (11)" respectively:

$$E_w = \{W_1^-, W_2^-, \dots, W_m^-\} = \{(\mathrm{Min}W_{ij} | j \in J), (\mathrm{Max}W_{ij} | j \in J')\} \quad (10)$$

$$E_B = \{W_1^+, W_2^+, \dots, W_m^+\} = \{(\mathrm{Max}W_{ij} | j \in J), (\mathrm{Min}W_{ij} | j \in J')\} \quad (11)$$

E. Calculate the distance of each alternative (Element) to the positive ideal solution (D_{iB}) and the Negative ideal solution (D_{iW})

$$D_{iB} = \sqrt{\sum_{j=1}^{m} (W_{ij} - W_j^+)^2}, \quad i = 1,2, \dots n \quad (12)$$

$$D_{iW} = \sqrt{\sum_{j=1}^{m} (W_{ij} - W_j^-)^2}, \quad i = 1,2, \dots n \quad (13)$$

F. Calculate the similarity to the worst condition C_i^* by "equation (14)"

$$C_i^* = \frac{D_{iW}}{D_{iB} + D_{iW}} \quad (14)$$

$C_i^* = 1$ if and only if the alternative solution has the best condition; and

$C_i^* = 0$ if and only if the alternative solution has the worst condition.

G. Finally, the alternative (elements) will be ranked according to C_i^* .

IV. RESULTS AND DISSECTIONS

This section will present the ranking of the elements of Five Stars Safety & Health Management System which was resulted from the AHP & TOPSIS methods as discussed on methodology section. Additionally, result will be checked for the compatibility with other result from last 5 years evaluation and accident reports.

1) Ranking of Five Starts Safety & Heath System Elements by AHP & TOPSIS

Pair-wise comparisons are constructed using Expert judgments evaluation for all criteria identified on Section 3-3.

Based on the expert's judgment, the pairwise comparisons among the eight criteria are used to construct reciprocal matrix as per "equation (1)":

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Table 13 : matrix of eigenvector

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
A	1	0.33	2	0.5	1	2	2	3
B	3	1	3	2	5	4	5	4
C	0.5	0.33	1	0.33	4	1	3	3
D	2	0.5	3	1	4	3	3	3
E	1	0.2	0.25	0.25	1	3	2	0.5
F	0.5	0.25	1	0.33	0.33	1	0.5	0.33
G	0.5	0.2	0.33	0.33	0.5	2	1	0.5
H	0.33	0.25	0.33	0.33	2	3	2	1

The matrix of eigenvector (the Relative Value Vector) is calculated by applying "equation (1)" for all eight criteria resulted from pairwise comparisons matrix and result as table 14. Accordingly, the eigenvector (priority vector) calculated using "equation (2)"and result as Table 14.

Table 14 : Priority Vector of Main Criteria

Main Criteria	*Priority Vector*
A: Cost Impact	0.121
B: Health and Safety Severity	0.295
C: Time Impact	0.120
D: Repetition	0.200
E: Implementation Cost	0.076
F: Implementation Time	0.052
G: Training	0.055
H: Authority	0.082

Furthermore, the consistency ratio (*CR*) will be calculated though equations 3-5 which used to calculate the maximum eigenvalue λ_{max} and the consistency index (*CI*) respectively. As result the CR was resulted as 0.085 which is less than 0.1 and indicates that judgements are reliable, and the exercise is valuable.

After that TOPSIS methods will be used to prioritize the Elements of five Stars safety and health Managements System by applying "equation (6)" to calculate the normalized decision matrix on an evaluation matrix which created as describe on section 3. Then use the priority vector in table 18 and multiplied it by the normalized decision matrix to form the weighted normalized decision matrix described by "equation (7)". Next step is to calculate the worst alternative E_w and the best alternative E_B as explained on section 3 by "equation (8)"and "equation (9)" respectively. However, the result as shown on table 15 below.

The final step in the TOPSIS calculation is the calculation of the distances to the negative ideal solution (D_{iw}) and the positive ideal solution (D_{iB}), and the worst condition $C_i^*$of

The 73 Elements of Five Stars Safety and Health Managements System using "equations (10) – (12)" respectively, Therefore, the ranking for the 73 Elements is presented on table 16 as result for above calculations.

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Table 15: Best And Worst Alternative

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
positive ideal solution (E_B)	0.0330	0.0872	0.0285	0.0301	0.0197	0.0235	0.0232	0.0215
negative ideal solution (E_w)	0.0083	0.0174	0.0071	0.0060	0.0049	0.0078	0.0077	0.0043

Table 16: Final Ranking of 5-Strars Health and Safety Management System

Rank	*Element*	*Rank*	*Element*	*Rank*	*Element*
1	2.2 Lock-Out Tag-Out	25	2.6 Compressed Gas Cylinders Pressure Vessels and Records	49	5.2 Safety and Occupational Hygiene Coordination
2	2.8 Risk assessment	26	5.6 First Aid Responder and Facilities	50	2.12General Electrical Installations and Flameproof
3	5.21 Work Permits	27	5.19 Written Safe Work	51	4.7 Accident Near Miss Recall
4	3.5 Alarm System	28	3.2 Locations marked, Floor Clear	52	4.6 Insurance Apportioning of Costs
5	2.3 Labeling of Switches, Isolators and Valves	29	3.3 Maintenance of Fire Equipment	53	1.6 Aisles and Storage Demarcated
6	2.21 Safety Harness	30	1.4 Plant Hygiene Facilities	54	4.3 Occupational Injury Disease Statistics
7	3.1 Fire Extinguishing Equipment Systems	31	1.9 Scrap and Refuse Bins Removal System	54	5.9 5-Star Safety Board
8	2.9 Motorized Equipment-Checklist, licensing	32	2.15 Head Protection	54	5.2 Planned Job Observations
9	1.1 Buildings and Floors	32	2.17 Footwear	57	5.23 Safety Policy
10	2.4 Ladders, Stairs, Walkways and Scaffolding	34	5.4 Safety Committees	58	5.22 Off-The-Job-Safety
11	3.4 Storage of Flammable and Explosive Material	35	1.3 Ventilation: Natural and Artificial	59	3.7 Security Roles for Safety
12	2.10 Machine/Hazardous Equipment Guarding	36	2.11 Electrical Equipment Maintenance	60	2.7 Hazardous Substance Control
13	5.7 First Aid Training	37	2.20 Hearing Conservation	61	5.18 Safety Specifications
14	1.2 Good Lighting: Natural and Artificial	38	5.5 Communication Systems	62	2.23 Control of Usage
15	1.7 Stacking and Storage	39	4.4 Property Damage and Business	63	5.11 Safety Reference Library
16	1.8 Housekeeping	40	5.16 Workplace Inspections	64	5.1 Managers Designated as Responsible for Safety and Health
17	2.5 Lifting Gear and Records	41	1.5 Pollution: Air, Ground & Water	65	4.5 Accident Statistics Kept
18	4.2 Internal Accident Reporting	42	2.16 Eye and Face Protection	65	5.10 Suggestion Scheme
19	5.15 Medical Examinations	42	2.19 Respiratory Equipment	67	5.14 Approved Safety Training Courses
20	5.3 5-Star Safety Representatives	42	2.22 Hand Protection	68	5.13 Orientation and Job Safety Training
21	2.1 Portable Electrical Equipment	45	5.8 Publicity, Bulletins, Newsletters, Safety Films	69	5.12 Annual Report Safety and Health Achievements
21	2.24 Notices and Signs Electrical, Mechanical, Protective Equipment	46	2.13 Hand Tools	69	5.17 Safety Performance Indicators
21	4.1 Occupation	47	3.6 Fire Drill and Emergency	71	2.14 Ergonomics

	Injury/Disease Record		Evacuation		
24	2.18Protective Clothing	48	1.10 Color Coding: Plant & Pipelines	72	3.9 Fire Coordinator Appointment
				73	3.8 Emergency Planning

V. CONCLUSION

Appling OSH regulation and insure all its requirements are followed in every company is essential rule. moreover, the Prioritization of OSH Element is a major issue in the success of OSH system. Without a standard prioritization criteria and methods, the probability of accident, cost and requires time will be increased. world range companies used one or two criteria for prioritization OSH implementation such as risk level and size of industry which led to less effective OSH system. Despite that there many MCDM approaches such as AHP-TOPSIS which considered as important strategic method of enforcement of OSH, but it infrequently used.

This research proposes a prioritization model based on AHP-TOPSIS approach which was based on an Eight-criterion decision making model (Cost Impact, Health and Safety Severity, Time Impact, Repetition, Implementation Cost, Implementation Time, Training and Authority Level). Each one of the main criteria is evaluated via several measurable sub criteria that can be assessed by information from 5-Stars System and SEC safety database. The decision main and sub criteria as well as their relative comparisons were decided by a group of experts through a Delphi methodology.

AHP method was used to determine the weights of main and sub criteria which were used in TOPSIS procedure to determine the overall priority index or the closeness coefficient (Ci). the advantage of this method is large number of elements can be handled on one calculation.

The final rank of 5- Safety and Health Management System elements from proposed AHP-TOPSIS Model is compared by two methods; the comparison with last 5 years evaluation of SEC project Departments and analyze the root cause for accidents which were happened on the same period. The result expected to significantly improve the effectiveness of 5-Stars system.

The main contributions of this research are summarized in the following points:

1. A new MCDM model for ranking of 5-stars Safety and Health Management System elements based on a hybrid AHP-TOPSIS approach. To the knowledge of the author, the application of this model to ranking of 5-Stars Safety and Health Management System elements is not reported in the literature.

2. The proposed method has high performance as it improves the TOPSIS performance regarding the relative importance of the distance to the ideal solution. This makes the results of the method more consistent because of using Eight main Criteria. The proposed model is a dynamic one that handles large number of Elements for prioritization, which is the case that all company 5-stars Safety and Health Management System deal with. The model accepts adding or removing Element/s to or from the list.

3. The model proposes Eight main criteria for prioritization instead of using only one or two criteria as commonly practiced worldwide. The proposed criteria assist targeting much more factors than the currently applied limited criteria approaches worldwide. The proposed criteria can be quantitatively assessed from available company data. Even though some criteria are qualitative in nature, they can be easily assessed by using appropriate Saaty [9-10] scale. Which is expected to minimize the subjectivity in evaluating the Elements against the criteria, making the use of AHP-TOPSIS an easy to apply method.

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