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Development of a Position-Based Occupational Health and Safety Competency Model in the Manufacturing Sector

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Abstract*— Identifying, developing and standardizing the safety competencies that employees are expected to possess contributes substantially to the development of the safety culture of institutions and organizations. Employees who are competent in occupational health and safety (OHS) are able to prevent accidents, to mitigate their consequences when accidents do occur, and to work in conformity with safety procedures. This study aims to determine the importance levels (weights) of the core OHS competencies that employees in five different positions — field technicians, foremen and shift supervisors, engineers and specialists, managers and top management — should possess, organized into 8 main categories and a total of 35 sub-competencies, to establish a ranking through scoring, and thereby to create an OHS competency model. The weights of the position-based main and sub-competencies were calculated using the Buckley analysis approach of the Fuzzy Analytic Hierarchy Process (FAHP), one of the multi-criteria decision-making methods. Buckley uses the geometric mean method to obtain fuzzy weights and performance scores; this method was preferred because it can readily be generalized to fuzzy situations and yields a single solution from the comparison matrices. Ten expert decision-makers, selected by purposive sampling in order to collect data with sufficient representativeness, participated in the study. The results show that the importance levels of OHS competencies differ according to position and that competency priorities vary depending on the organizational role. For field technicians, who operate at the operational level, the most critical competency was found to be holding professional competence, with a weight of 0.156. Likewise, for the foreman and shift supervisor position, holding the professional competence appropriate to the primary job performed emerged as the most important competency, with a weight of 0.247. This finding indicates that technical knowledge and practical skill constitute the fundamental elements of safe working in field operations. For engineers and specialists, the most important competency was determined to be verifying compliance with emergency response plans, with a weight of 0.092. At the managerial and top-management levels, exercising safety leadership was identified as the most critical competency, with weights of 0.241 and 0.224 respectively. Overall, the findings suggest that while professional and technical competence is prioritized among field employees and their immediate supervisors, competencies related to leadership, organizational management and safety culture become more prominent at higher management levels.

***Keywords*— Buckley approach, competency model, fuzzy AHP, manufacturing sector, occupational health and safety.**

I. Introduction

When the concept of occupational health and safety competency is examined in the literature, it is found that existing studies aim to determine the level of OHS competency, to build models by identifying safety competency requirements, and to measure the effects of training programs on OHS competency levels. The great majority of these studies, however, have been conducted for occupational safety specialists, workplace physicians and nurses; in addition to these groups, managers, site supervisors, engineers and workers employed in sectors such as construction, mining, aviation and metalworking, as well as process safety and fire safety engineers, have also been covered. Yet all employees working in a workplace carry the responsibility of creating the safety culture. Relying solely on occupational safety professionals or on managers in particular sectors to identify workplace hazards obstructs the formation of a safety climate. It has been shown that a competency model requires a hierarchy or a level for each group [1].

It has also been determined that studies on occupational health and safety competencies propose recurring (identical or similar) competencies, that definitions, explanations and indicators of the competencies are included only sporadically, and that OHS competency requirements are absent in particular for technician, engineer and specialist positions.

Definitions of safety competency vary in the literature. The concept of occupational safety competency is described as the knowledge, skills, behavior, attitudes, aptitudes, understanding, abilities, experience and salient characteristics that a person must possess in order to ensure that work is carried out safely. Competent employees are expected not only to be knowledgeable but also to draw on their experience and skills, to act in accordance with procedures and to display safe behavior.

Competency requirements are themselves undergoing change today because of the rapid advance of technology and the establishment of work systems integrated with automation. Safety competencies must therefore be reviewed and updated with specific positions in mind.

The present study is a continuation of our previous article, “Occupational Health and Safety Competencies: A Systematic Literature Review”.

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It aims to identify the core competencies that employees working in five different positions in the manufacturing sector — field technicians (junior and senior), foremen and shift supervisors, engineers and specialists (junior, senior and lead), managers (unit managers, department managers, directors and the like) and top management (directors, deputy directors, group presidents, deputy general managers and general managers) — should possess in the field of occupational health and safety; to determine the importance levels of the identified main and sub-competencies by weighting them; and, in this way, to construct an occupational health and safety competency model.

The construction of a competency model specific to the manufacturing sector, the holistic treatment of the corporate hierarchy extending from the field technician up to top management, the determination of competencies on a position basis, and the model's capacity to guide the practices of the human resources function both reveal the strengths of the study and make it distinctive.

II. Method

A flow chart of the research steps is shown in Fig. 1.

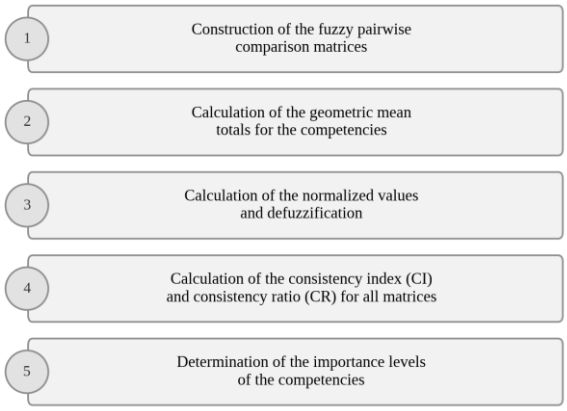

Fig. 1 Flow chart of the measurement method

Expert opinion was sought in this study because the literature contains only a limited number of sources capable of guiding the research; because the experience and knowledge of decision-makers with expertise in the scientific field could be drawn upon; because such experts broaden the research and increase its depth by providing new perspectives; and because they offer insight into how the research results may be used by practitioners.

Information on the demographic characteristics of the participating expert decision-makers, based on their achievements and experience, was obtained through the first part of the questionnaire. In this part, data were collected on the experts' years of professional experience, their duties at their workplaces, the certificates they hold, the conference presentations they have delivered, their published articles, the courses they have taught, and their fields and degrees of graduation.

The second part of the questionnaire was designed to determine the weights (importance levels) of the expert decision-makers by scoring them in terms of job descriptions, academic standing and professional experience. The criteria relating to the achievements and experience of the experts were listed, and the extent to which experts meeting these criteria would contribute to the study was scored using a five-point Likert scale. The explanations of the scale used in the questionnaire are as follows.

1 – Contributes very little.
2 – Contributes little.
3 – Contributes moderately.
4 – Contributes highly.
5 – Contributes very highly.

The achievement and experience criteria met by each participating expert were marked, the mean weight scores of the experts were calculated, and normalized values were computed over their total scores so that the total weight of the ten experts equals 1. The expert weights are shown in Table I.

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TABLE I
DEMOGRAPHIC CHARACTERISTICS AND EXPERT WEIGHTS

Demographic Characteristic	Category	Mean Score	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10
Years of professional experience	5–10 years (10th year included)	3.1	x		x			x		x		
	10–15 years (15th year included)	3.8				x			x		x	x
	15–20 years (20th year included)	3.9		x			x					
Position at the workplace	Occupational safety specialist / engineer	5	x			x		x	x			x
	Workplace physician	3.8								x		
	Manufacturing engineer or manager	3.8			x		x					
	Human resources specialist	3		x							x	
Certificates held	Occupational Safety Specialist Certificate	3.4	x			x		x	x			x
	NEBOSH International General Certificate in Occupational Health and Safety	3.7	x			x		x				x
	Workplace Physician Certificate	3.2								x		
Delivering a presentation on occupational health and safety at a national and/or international conference	Delivering a presentation	3.5	x						x			x
Teaching in occupational health and safety associate, bachelor's and/or master's programs at an accredited university	Teaching courses	4.1	x									
Graduation in fields such as Occupational Health and Safety, Public Health, Emergency and Disaster Management	Associate degree	2.9				x						x
	Bachelor's degree	3.2								x		
	Master's degree	3.8			x			x				
Graduation in Social Sciences (Human Resources Management, Psychology, Sociology, Public Relations, etc.)	Associate degree	1.9										x
	Bachelor's degree	2.2									x	
	Master's degree	2.6		x								
Graduation in Engineering Sciences (Industrial, Mechanical, Manufacturing, Environmental, etc.)	Associate degree	2.9										
	Bachelor's degree	3.7	x		x		x		x			x
	Master's degree	4.2						x				
	TOTAL SCORE	**71.7**	**26.5**	**9.5**	**14.4**	**18.8**	**11.4**	**23.2**	**19.4**	**13.3**	**9**	**27.9**
	EXPERT WEIGHT	**1**	**0.37**	**0.13**	**0.20**	**0.26**	**0.16**	**0.32**	**0.27**	**0.19**	**0.13**	**0.39**

In line with the opinions of the expert decision-makers and a comprehensive review of the literature, a competency pool containing 35 occupational health and safety competencies was created. The OHS competencies that employees in each position (field technician, foreman and shift supervisor, engineer and specialist, manager and top manager) should possess may differ. The third part of the questionnaire was therefore designed to distribute the listed competencies across positions and, in this way, to identify the competencies that are of importance for each position.

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Before the questionnaire was administered, the expert decision-makers were informed that they should mark all the options they considered to be of equal importance. The experts were thus able to mark more than one option that they supported to the same degree. The weight of the marking expert was divided by the number of options marked, and the weight was shared accordingly. The purpose of this calculation was to prevent any difference in the total weight of each question, to observe a proportional and balanced distribution, and thereby to ensure balance and consistency in the overall scoring. For example, three different positions were marked as needing to possess the competency of conducting field inspection and supervision. When the responses were distributed according to the expert weights (Table II) so that the total weight equals 1, the weight was calculated as 0.306 for the foreman and shift supervisor position, 0.590 for the engineer and specialist position and 0.104 for the manager position (Fig. 2); all three marked positions were included in the evaluation and appear in the final competency tables.

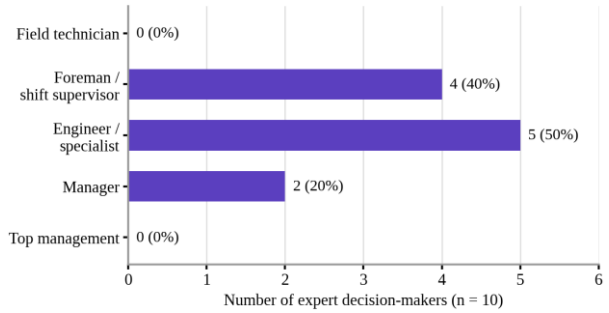

Fig. 2 Distribution across positions of the competency "conducting field inspection and supervision" according to the choices of the expert decision-makers

TABLE II
WEİGHTS AND RESPONSES OF THE EXPERT DECİSİON-MAKERS

Expert No.	Expert Weight	Responses
Expert 1	0.153	Engineer / specialist (junior, senior, lead)
Expert 2	0.055	Foreman / shift supervisor; Manager (unit manager and department manager)
Expert 3	0.083	Engineer / specialist (junior, senior, lead)
Expert 4	0.108	Engineer / specialist (junior, senior, lead)
Expert 5	0.066	Foreman / shift supervisor
Expert 6	0.134	Engineer / specialist (junior, senior, lead)
Expert 7	0.112	Engineer / specialist (junior, senior, lead)
Expert 8	0.077	Manager (unit manager and department manager)
Expert 9	0.052	Foreman / shift supervisor
Expert 10	0.161	Foreman / shift supervisor

The final position-based occupational health and safety competency tables were obtained after the third questionnaire. Field technicians have 4 main and 14 sub-competencies; foremen and shift supervisors 5 main and 18 sub-competencies; engineers and specialists 7 main and 18 sub-competencies; managers 7 main and 19 sub-competencies; and members of top management 3 main and 8 sub-competencies.

In calculating the importance levels of the competencies, the linguistic expressions corresponding to the answers given by the ten expert decision-makers to the questions comparing the importance levels of two competencies in the fourth questionnaire were first used as indicated in Table III. The triangular fuzzy numbers (l, m, u) obtained for each question were multiplied by the weights of the experts to yield the weighted aggregate triangular fuzzy numbers.

TABLE III
LİNGUİSTİC EXPRESSİONS AND IMPORTANCE LEVELS EXPRESSED BY TRİANGULAR FUZZY NUMBERS

Scores	Linguistic Expressions	Importance Level	Scores	Linguistic Expressions	Reciprocal of the Importance Level
1	Definitely very high	(5, 6, 6)	6	Exactly equal	(1, 1, 1)
2	Very high	(4, 5, 6)	7	Slightly high	(1/3, 1/2, 1)
3	Above moderately high	(3, 4, 5)	8	Moderately high	(1/4, 1/3, 1/2)
4	Moderately high	(2, 3, 4)	9	Above moderately high	(1/5, 1/4, 1/3)
5	Slightly high	(1, 2, 3)	10	Very high	(1/6, 1/5, 1/4)
6	Exactly equal	(1, 1, 1)	11	Definitely very high	(1/6, 1/6, 1/5)

Weighted comparison matrices were prepared for each sub-competency. The points at which the competencies are compared with themselves in the matrix are denoted by the importance level (1, 1, 1).

Where the comparison moves from exact equality in the direction of an increase in the importance of the other competency, the reciprocal of the importance level (1/u, 1/m, 1/l) was calculated and placed in the comparison matrices.

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The weights (importance levels) of the position-based main and sub-competencies were calculated with the Buckley method of fuzzy AHP, one of the multi-criteria decision-making methods. Buckley used the geometric mean method in order to obtain fuzzy weights and performance scores.

In the literature, the Buckley fuzzy AHP method has been used for purposes such as comparing software alternatives [2], calculating criterion weights in determining the economic performance of the agricultural sectors of countries [3], selecting the most suitable alternative bank [4], determining the type of vessel that a private shipyard should build [5], determining the importance levels of the criteria in raw material supplier selection [6], and weighting the probability and severity of risk parameters [7]. In fuzzy AHP, a disadvantage arising from division by zero is encountered in Chang's method [8]. The Buckley method prevents this problem through the geometric mean approach and is able to assign a positive weight to every competency even when the difference between the weights of the competencies is minimal.

III. Solution Steps According To The Algorithm Of The Buckley Approach

Step 1: The fuzzy comparison matrix is constructed.

A decision matrix consisting of triangular fuzzy numbers (l, m, u) is created for the competencies on the basis of the expert evaluations. The elements of each comparison matrix are of the form aij = (lij, mij, uij). The diagonal elements (i = j) are always (1, 1, 1). The positive pairwise comparison matrix A is given in (1).

$$A = (a_{ij}),\ a_{ii} = (1, 1, 1) \quad (1)$$

Step 2: The fuzzy geometric mean is calculated for each competency. The l, m and u values in each row are multiplied among themselves, their n-th roots are taken, and the geometric mean fuzzy number given in (2) is obtained.

$$r_i = ((\prod l_{ij})^{1/n}, (\prod m_{ij})^{1/n}, (\prod u_{ij})^{1/n}) \quad (2)$$

$$r_i = (L_i, M_i, U_i) \quad (3)$$

Step 3: The geometric mean totals are calculated for all competencies, as shown in (3).

$$\sum r_i = (\sum l_i, \sum m_i, \sum u_i) \quad (4)$$

Step 4: The fuzzy weight vector wi is calculated. Normalized values are obtained by dividing the geometric mean of each competency by the total, as given in (4). The weights, that is the importance levels, are obtained in this way.

$$w_i = (l_i / \sum u_i,\ m_i / \sum m_i,\ u_i / \sum l_i) \quad (5)$$

Step 5: Since the calculated competency weights are fuzzy, the defuzzification operation is carried out with the equation given in (5), which is presented in the study of Kiani Mavi et al. [9].

$$W_i = [(w_i^u - w_i^l) + (w_i^m - w_i^l)] / 3 + w_i^l \quad (6)$$

IV. Steps For Calculating Saaty's Consistency Ratio

Step 1: Calculation of the approximate eigenvalue (eigenvector).

The geometric mean of each row of the comparison matrix obtained is taken. The values are normalized by dividing them by the row totals.

Step 2: Calculation of the largest eigenvalue (λmax).

The defuzzified pairwise comparison matrix is multiplied by the weight vector, and the resulting vector is divided element by element by the weight vector. The mean of the values obtained is then taken, that is, they are divided by the number of elements.

Step 3: Calculation of the consistency index (CI).

CI is calculated in order to measure the consistency of the decision-maker's pairwise comparisons and expresses numerically how inconsistent the matrix is. The smaller the CI value, the higher the consistency.

Step 4: Random index (RI).

The index determined by Saaty according to the size of the matrix (Table IV) is taken as the basis [10].

Table IV
Random Indices Determined by Saaty

Matrix Size	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random Index	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	1.52	1.54	1.56	1.58	1.59

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Step 5: Consistency ratio (CR). In all the matrices prepared in this study the consistency ratio was calculated as below 0.10, and it was understood that the matrices have a consistent distribution.

V. Position-Based Weighting Of Occupational Health And Safety Competencies

The importance levels of the main competencies determined for field technicians were calculated by following the solution steps of the Buckley approach. The importance levels of the main and sub-competencies determined for the field technician position were compared with one another in pairs.

Step 1: The weighted comparison matrix constructed accordingly is shown in Table V.

Table V
Weighted Comparison Matrix of the Importance Levels of the Main and Sub-Competencies Determined for the Field Technician Position

	A	B	C	D
A	(1, 1, 1)	(0.960, 1.343, 1.754)	(0.753, 1.024, 1.303)	(2.214, 2.843, 3.472)
B	(0.570, 0.744, 1.042)	(1, 1, 1)	(0.494, 0.699, 1.002)	(1.867, 2.444, 3.082)
C	(0.767, 0.977, 1.328)	(0.998, 1.431, 2.024)	(1, 1, 1)	(2.239, 2.864, 3.524)
D	(0.288, 0.352, 0.452)	(0.324, 0.409, 0.535)	(0.284, 0.349, 0.447)	(1, 1, 1)

A: Professional competencies
B: Competencies relating to emergency management
C: Competencies relating to hazard and risk analysis
D: Technical competencies

Step 2: The l, m and u values (triangular fuzzy numbers) in the rows were multiplied among themselves. The n-th root of each result was taken; the value of n was taken as the number of factors in the matrices.

Step 3: The geometric mean totals were calculated for all competencies.

Step 4: Normalized values were calculated by dividing the geometric mean of each competency by the total (Table VI).

Table VI
Calculations Relating to the Second, Third and Fourth Steps

L	**A**	**B**	**C**	**D**	**Product (l)**	**4th root**	**l / Σu**
A	1	0.960	0.753	2.214	1.600	1.125	0.210
B	0.570	1	0.494	1.867	0.526	0.852	0.159
C	0.767	0.998	1	2.239	1.714	1.144	0.214
D	0.288	0.324	0.284	1	0.027	0.403	0.075
					L TOTAL	3.524	
M	**A**	**B**	**C**	**D**	**Product (m)**	**4th root**	**m / Σm**
A	1	1.343	1.024	2.843	3.910	1.406	0.323
B	0.744	1	0.699	2.444	1.271	1.062	0.244
C	0.977	1.431	1	2.864	4.004	1.415	0.325
D	0.352	0.409	0.349	1	0.050	0.473	0.109
					M TOTAL	4.356	
U	**A**	**B**	**C**	**D**	**Product (u)**	**4th root**	**u / Σl**
A	1	1.754	1.303	3.472	7.935	1.678	0.476
B	1.042	1	1.002	3.082	3.218	1.339	0.380
C	1.328	2.024	1	3.524	9.472	1.754	0.498
D	0.452	0.535	0.447	1	0.108	0.573	0.163
					U TOTAL	5.345	

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Step 5: Defuzzification was performed with the equation given in the study of Kiani Mavi et al. [9] (Table VII).

TABLE VII
DEFUZZİFİCATİON CALCULATİON İN THE FİFTH STEP

For A	
l(A)	0.210
m(A)	0.323
u(A)	0.476
W(A) = [(u−l) + (m−l)] / 3 + l	**0.337**
For B	
l(B)	0.159
m(B)	0.244
u(B)	0.380
W(B) = [(u−l) + (m−l)] / 3 + l	**0.261**
For C	
l(C)	0.214
m(C)	0.325
u(C)	0.498
W(C) = [(u−l) + (m−l)] / 3 + l	**0.346**
For D	
l(D)	0.075
m(D)	0.109
u(D)	0.163
W(D) = [(u−l) + (m−l)] / 3 + l	**0.116**

TABLE VIII
IMPORTANCE LEVELS OF THE MAİN COMPETENCİES DETERMİNED FOR FİELD TECHNİCİANS

Competencies	Importance Levels (W)
A	0.337
B	0.261
C	0.346
D	0.116

Ranking: C > A > B > D

According to the ranking obtained, competency C has the highest importance level among the main competencies that field technicians should possess. The importance level of competency D is markedly lower than that of the other competencies. In resource and priority planning, emphasis should be placed on the acquisition of competencies C and A, whereas the acquisition of competencies B and D should be regarded as necessary at a moderate and low level and as complementary (Table VIII).

The same solution steps were followed for all the competencies determined, in order to establish and compare the importance levels of the main and sub-competencies of occupational health and safety across the five positions covered in this study.

VI. RESULTS

The position-based normalized weights of the occupational health and safety competencies determined for field technicians, foremen and shift supervisors, engineers and specialists, managers and top managers working in the manufacturing sector are given in Table IX.

TABLE IX
POSİTİON-BASED NORMALİZED WEİGHTS OF THE OCCUPATİONAL HEALTH AND SAFETY COMPETENCİES

Occupational Health and Safety Competencies			References	Data Source	Total Weights per Position / Normalization (ΣW = 1)				
No.	**Main Competency Categories**	**Sub-Competencies**			**Field Technician**	**Foreman / Shift Supervisor**	**Engineer / Specialist**	**Manager**	**Top Management**
1	**Professional Competencies**	Holding the professional competence appropriate to the primary job performed	[11], [12]	Secondary data	0.156	0.247			
2		Holding an operator's licence for the lifting equipment used	[11], [12]	Secondary data	0.078				
3		Holding a driving licence for the vehicles used	[13]	Secondary data	0.050				
4	**Emergency Management**	Performing basic first-aid procedures	[14]	Secondary data	0.064	0.031			
5		Intervening in accordance with the measures defined for fire safety and with extinguishing techniques	Expert opinion	Primary data	0.059	0.034			
6		Acting in accordance with the procedures in the event of an occupational accident	Expert opinion	Primary data	0.047	0.027			
7		Acting in accordance with the instructions in emergencies	Expert opinion	Primary data	0.046	0.037			
8		Verifying compliance with emergency response plans	Expert opinion	Primary data		0.033	0.092	0.075	
9	**Hazard and Risk Analysis**	Working in conformity with work instructions / displaying safe behavior	Expert opinion	Primary data	0.132	0.039			

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Occupational Health and Safety Competencies			References	Data Source	Total Weights per Position / Normalization (ΣW = 1)				
No.	Main Competency Categories	Sub-Competencies			Field Technician	Foreman / Shift Supervisor	Engineer / Specialist	Manager	Top Management
10		Reporting and making suggestions when an unsafe condition or behavior or a near miss is detected	[15], [16]	Secondary data	0.038				
11		Applying in the field the requirements and the hierarchy of the appropriate protection systems for work at height	[17]	Secondary data	0.089	0.026	0.039		
12		Applying the safety requirements for vehicle and pedestrian traffic	[17]	Secondary data	0.050		0.025		
13		Performing autonomous OHS checks on the equipment used and reporting the nonconformities identified	[17]	Secondary data	0.033	0.026			
14		Working safely in confined spaces, hot work, excavation work and energy and high-voltage electrical work by obtaining permits and exercising control in line with the instructions	Expert opinion	Primary data	0.065	0.036	0.031		
15		Identifying and managing the OHS risks of the process	[18]	Secondary data		0.068	0.057	0.083	
16		Managing the lessons learned from incidents	Expert opinion	Primary data		0.039		0.028	
17		Implementing and managing administrative control measures effectively	[17]	Secondary data				0.070	
18		Conducting systematic incident and accident investigations	[17]	Secondary data			0.055	0.043	
19	**Communication and Training**	Exercising safety leadership	Expert opinion	Primary data		0.109	0.064	0.241	0.224
20		Delivering induction training effectively	[19]	Secondary data		0.037	0.015		
21	**Field Inspection / Supervision**	Conducting field inspection and supervision	[15]	Secondary data		0.089	0.070	0.076	
22		Supervising the proper use of personal protective equipment	Expert opinion	Primary data		0.035	0.029	0.043	
23		Overseeing that the contractors invited to the company or under one's responsibility carry out their work in accordance with OHS procedures	Expert opinion	Primary data		0.027	0.026		
24	**OHS Management System**	Observing OHS requirements in procurement processes	[18]	Secondary data			0.044	0.008	
25		Identifying OHS knowledge, skills and competencies and integrating them into job descriptions	[18]	Secondary data			0.082	0.016	
26		Adopting innovative OHS approaches	[18]	Secondary data			0.061	0.019	0.063
27		Providing a safe and healthy working environment	[18]	Secondary data				0.045	0.137
28		Ensuring the conformity of the operations of the organization with the relevant legal regulations and with company policies and procedures	[18]	Secondary data				0.040	0.139
29		Determining and managing the resources required for the implementation of OHS programs	[18]	Secondary data				0.033	0.133
30		Establishing the OHS policy and objectives	[18]	Secondary data					0.136
31	**Technical Competencies**	Observing and ensuring the application of the standard occupational safety requirements during the technical design of facilities, systems, processes and machinery	[18]	Secondary data			0.087	0.055	
32		Proposing occupational safety and engineering measures and requirements for machines, devices and equipment that require guarding	[17]	Secondary data	0.093		0.035	0.024	
33	**Psychological Health and Well-Being**	Supporting the improvement of employee health	[20]	Secondary data			0.043	0.027	0.044
34		Conducting fitness-for-work assessments for employees	[16]	Secondary data		0.061	0.014	0.015	
35		Disseminating the safety culture to all stakeholders	[21]	Secondary data				0.058	0.124

Positions: Field Technician (junior, senior); Foreman / Shift Supervisor; Engineer / Specialist (junior, senior, lead); Manager (unit manager, department manager, director, etc.); Top Management (director, deputy director, group president, deputy general manager, general manager).

The competencies relating to the knowledge, skills and attitudes within the scope of occupational health and safety that employees in the manufacturing sector need in order to conduct operations safely and sustainably have been ranked according to their importance levels. The evaluations concerning the first five competencies determined for each position are presented below.

The competency of holding professional competence was determined to be the competency with the greatest weight for the field technician and the foreman and shift supervisor positions. In order to remain open to changing technologies and practices and to innovations in the workplace, and to manage risks and errors in the field, the possession of the relevant qualification certificates should be sought as the first requirement in the recruitment process.

The competency of working in conformity with work instructions and displaying safe behavior is the competency with the second highest value for field employees, while it ranks sixth at the foreman and shift supervisor level. Working in accordance with instructions in the field does not vary from one employee to another and provides a standard level of safety. Encouraging safe behavior in the workplace is a critical part of managing health and safety, because behavior turns systems and procedures into reality [22].

The competency of proposing occupational safety and engineering measures and requirements for machines, devices and equipment that require guarding ranks third in importance for field technicians, twelfth for the engineer and specialist position and fifteenth for the manager position. Machines and equipment requiring guarding fall within the high-risk group, and machine-based technical solutions should be developed. The ability of employees to identify potential risks proactively, to verify that the appropriate safety measures are in working order, to keep them operational and to put forward practical improvement proposals is of great importance in preventing near misses and accidents.

The competency of applying in the field the requirements and the hierarchy of the appropriate protection systems for work at height ranks fourth for field technicians, seventeenth for foremen and shift supervisors and eleventh for engineers and specialists. Work at height is one of the high-risk activities in the manufacturing sector, carried out above all in maintenance and repair operations with equipment such as platforms, ladders and personnel lifts. Any work performed in areas where there is a difference in level and where a fall could result in injury is regarded as work at height [23]. The effect and the priority of the measures must be assessed correctly and the safest option must be enforced.

The competency of exercising safety leadership ranks second for foremen and shift supervisors, fifth for engineers and specialists, and first for managers and top managers.

Employees in foreman and shift supervisor positions generally assume the role of team leader, and the professional knowledge and competencies they possess directly affect the safety of their teams. The safety of the workplace should not be left to occupational health and safety professionals alone. The most important factor governing employees' perceptions and shaping their behavior lies in the attitudes of management. Managers should therefore take a clear stand against unsafe behavior and motivate employees through safe behavior.

The competency of conducting field inspection and supervision ranks third for foremen and shift supervisors, fourth for engineers and specialists and fifth for managers. Surveillance of the working environment must be carried out as a continuous activity. The reason for this is that the hazards and risks in the working environment change constantly and that new health and safety problems arise accordingly. Under the Turkish Regulation on Occupational Health and Safety Services, in-house occupational health and safety units and joint health and safety units are responsible for guiding the employer on the surveillance of the working environment, in a manner covering every kind of protective, preventive and corrective activity to be carried out against health and safety risks in the workplace, and for preparing recommendations and submitting them for approval, with a view to contributing to the creation of a healthy and safe working environment [24].

The competency of identifying and managing the occupational health and safety risks of the process ranks fourth for foremen and shift supervisors, seventh for engineers and specialists and second for managers. Processes generally comprise multiple steps and combined tasks, and each risk identification made between these steps clarifies the measures that employees may take at every stage. The identification and management of process risks lies at the heart of establishing a proactive safety strategy in the workplace. This approach ensures that hazards are brought under control before they emerge.

The competency of conducting fitness-for-work assessments for employees ranks fifth for foremen and shift supervisors and eighteenth for engineers and specialists and for managers. On the basis of the assessment carried out, a decision is made as to whether the person is fit to work in the job concerned, may be fit subject to certain restrictions, may be fit if certain modifications are made, or is not fit to perform the job [25]. With compatibility in mind, the characteristics of the employee and the characteristics of the job should largely coincide in job placement.

The competency of verifying compliance with emergency response plans ranks first for engineers and specialists, sixth for managers and thirteenth for foremen and shift supervisors.

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Emergency plans contain information on the strategic practices prepared in order to minimize the potential effects of any emergency. Verifying that the process of compliance with the plans and instructions is being operated increases the effectiveness of the response process. Compliance checks are required in order to identify potential shortcomings. The responsibilities of the employees and managers assigned in emergencies should be clearly stated in their job descriptions.

The competency of observing the standard occupational safety requirements during the technical design of facilities, systems, processes and machinery ranks second for engineers and specialists and fourth for managers. In new facilities, machines, production lines or systems, the legal and minimum occupational health and safety requirements arising from regulations and standards must be taken into account, and occupational health and safety risks must be foreseen at the design stage so that measures can be taken systematically. This preventive engineering approach ensures that the risk is eliminated at its source.

The competency of identifying occupational health and safety knowledge, skills and competencies and integrating them into job descriptions ranks third for engineers and specialists and seventeenth for managers. The occupational health and safety responsibilities of every employee must be clearly defined, these competencies must be associated with training, skills and experience and added to the employee's duties, and they must be measurable. Clarifying the responsibilities of employees at every level is an effective method of building a sustainable safety culture at the corporate level. Providing clarity in job descriptions increases employees' sense of responsibility.

The competency of effectively implementing and managing administrative control measures was selected only for managers and ranks third in importance. Administrative control measures are measures taken to reduce risk by regulating the behavior of employees, the organizational structure and work processes in cases where hazards cannot be eliminated in occupational health and safety management and where technical and engineering measures remain insufficient. They include activities such as arranging shifts, operating permit-to-work systems, rotation and job exchange, preparing instructions and procedures, distributing tasks, and establishing job descriptions.

The competency of ensuring the conformity of the operations of the organization with the relevant legal regulations and with company policies and procedures was selected only for top management and ranks second in importance. Meeting this competency means fulfilling the legal obligations relating to occupational health and safety, applying internal policies and procedures throughout all processes, and monitoring, measuring and improving them systematically.

The competency of providing a safe and healthy working environment was selected only for top management and ranks third in importance. Occupational Health and Safety Law No. 6331 states that the employer shall ensure that the necessary checks, measurements, examinations and investigations are carried out with regard to the working environment in terms of occupational health and safety and to the identification of the risks to which employees are exposed in that environment. An environment in which employees feel safe is the most fundamental source of motivation. Top management should support projects for improving the working environment, such as ergonomic design and rest areas.

The competency of establishing the occupational health and safety policy and objectives was selected only for top management and ranks fourth in importance. A policy setting out the company's vision, decisions and commitments concerning occupational health and safety must be established, together with corporate and strategic objectives associated with that policy. The objectives set direct teams towards a common effort, and these objectives gain value through the ownership of top management.

The competency of determining and managing the resources required for the implementation of occupational health and safety programs was selected only for top management and ranks fifth in importance. The resources required for establishing, operating and sustaining the occupational health and safety management system must be provided and their availability guaranteed. Resources such as budget, human resources, time, hardware and software that are needed for occupational health and safety practices to be operated without interruption must be identified, provided to an appropriate extent and prioritized correctly. Annual occupational health and safety budgets should be defined and the use of resources monitored.

VII. Discussion

At the top of the list of occupational health and safety competencies prepared for the field technician position, fundamental knowledge and behavioral elements such as professional qualification and safe working in accordance with work instructions come to the fore. It is understood that the ability of field technicians to use the right tools in the right way, to carry out their work with an understanding of the processes, and to internalize safe behavior patterns constitutes the elements of the two most important competencies.

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In the list of occupational health and safety competencies prepared for the foreman and shift supervisor position, the highest priority is seen to be given to professional competence, followed by managerial and supervisory roles such as leadership, field inspection and risk management. This shows that foremen and shift supervisors hold roles in the field that combine their technical expertise with the ability to exercise safety leadership and to blend guidance and supervision competencies.

In the list of occupational health and safety competencies prepared for the engineer and specialist position, the highest priorities are given to preparedness for emergencies, the ability to integrate safety requirements at the design stage and command of the management system approach, that is, to verifying the implementation of emergency plans, observing OHS requirements in the design of facilities, processes and machines, and integrating OHS knowledge and skills into job descriptions. The competencies of field inspection, safety leadership and the adoption of innovative OHS approaches occupy the middle ranks. These competencies show that the engineer and specialist assumes not only a technical role but also a guiding role that develops the safety culture.

In the list of occupational health and safety competencies prepared for the manager position, the competency of exercising safety leadership ranks at the top with by far the highest weight. This reveals that modelling safe behavior and reflecting the safety vision to the team are among the most critical responsibilities of managers.

The competencies that follow immediately after — identifying and managing OHS risks and implementing administrative control measures — emphasize the need for managers to manage risks proactively.

In the list of occupational health and safety competencies prepared for the top management position, the competency of exercising safety leadership again ranks at the top. This competency emphasizes the need for top managers to provide direction as leaders who inspire the entire organization through their exemplary behavior, attitudes and decisions. The competencies of ensuring compliance with legal regulations and procedures and of providing a safe working environment rank second and third. Top managers are expected to ensure conformity with legislative and standard requirements and to take an active role in the continuity of healthy working conditions.

VIII. Conclusion And Recommendations

In this study, the importance levels of the core occupational health and safety competencies that employees in five different positions should possess were determined across 8 main categories and a total of 35 sub-competencies, and an occupational health and safety competency model specific to the manufacturing sector was constructed. The model obtained serves as a guide that will help enterprises to improve their occupational health and safety performance and to manage risks more effectively.

Table X
Critical Position-Based Occupational Health and Safety Competencies

Positions	Ranking	Competencies	Weight
Field Technician	1	Holding professional competence	0.156
	2	Working in conformity with work instructions / displaying safe behavior	0.132
	3	Proposing occupational safety and engineering measures and requirements for machines, devices and equipment that require guarding	0.093
Foreman / Shift Supervisor	1	Holding the professional competence appropriate to the primary job performed	0.247
	2	Exercising safety leadership	0.109
	3	Conducting field inspection and supervision	0.089
Engineer / Specialist	1	Verifying compliance with emergency response plans	0.092
	2	Observing the standard occupational safety requirements during the technical design of facilities, systems, processes and machinery	0.087
	3	Identifying OHS knowledge, skills and competencies and integrating them into job descriptions	0.082
Manager	1	Exercising safety leadership	0.241
	2	Identifying and managing the OHS risks of the process	0.083
	3	Implementing and managing administrative control measures effectively	0.070
Top Management	1	Exercising safety leadership	0.224
	2	Ensuring the conformity of the operations of the organization with the relevant legal regulations and with company policies and procedures	0.139
	3	Providing a safe and healthy working environment	0.137

The three occupational health and safety competencies with the highest weight for each position, representing the critical OHS competencies that stand out in the relevant positions, are presented in Table X.

When the positions are compared, the highest weight for field technicians belongs to the competency of holding professional competence, which was calculated as 0.156. This is followed, with 0.132, by working in accordance with work instructions and displaying safe behavior. Likewise, in the foreman and shift supervisor position, the competency of holding the professional competence appropriate to the primary job performed has one of the highest weights in the entire table, at 0.247. This shows that at the operational level technical knowledge and practical skill are the fundamental determinants of OHS performance.

As one moves to the management level, the competency of safety leadership is seen to come clearly to the fore. While safety leadership has a weight of 0.109 in the foreman and shift supervisor position, this value rises to 0.241 in the manager position. In top management, safety leadership was determined to be the most critical competency, with a weight of 0.224. This result demonstrates that the leadership role is of critical importance for creating and sustaining an OHS culture at the organizational level.

In the engineer and specialist group, unlike the other positions, a more systematic and preventive approach comes to the fore. Verifying compliance with emergency response plans (0.092), observing OHS standards in technical design processes (0.087) and integrating OHS competencies into job descriptions (0.082) have weights that are very close to one another. This shows that in engineering and specialist roles occupational health and safety is addressed not only in its operational dimension but also in the dimension of process and system design.

At the top-management level, alongside safety leadership, the competencies of legal compliance and of creating a safe working environment account for a large share. While the competency of ensuring that the operations of the organization are conducted in accordance with legislation and company procedures has a weight of 0.139, the competency of creating a safe and healthy working environment is very close to it at 0.137. These results show that the fundamental responsibility of top management in the field of occupational health and safety is strategic governance, legal compliance and the sustainability of the safety culture.

In line with the results of this study, it is recommended that training and development plans and performance criteria be customized for each position according to the competencies identified. The introduction of new competencies corresponding to future developments should continue in subsequent studies.

In the design and implementation of human resources functions, it is important that this framework be evaluated and applied specifically to operations such as recruitment and selection, training and development, performance and competency management, reward management and leadership development. Similar studies should be carried out in the future and extended to all sectors. The positions used in competency models should be made more specific. Measurement and assessment tools for occupational health and safety competencies should be developed and the measurement results contributed to the literature. Studies revealing the effect of OHS competencies on the occupational safety culture should be conducted. Competency models differ across international systems; competency models to be prepared at the national level should therefore be benchmarked against international standards and models.

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