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ORIGINAL ARTICLE

Incorporating Lead and Lag Key Performance Indicators Technique into AHP Method for HSE Management System Performance Measurement in Selected Food Products Industry

FARSHAD KAFAEI[1*], ESMAEIL KHAZAEI POUR[2], NASTARAN KHAEFI[3]

*[*1] Environmental Management (HSE), Managemen Department, West Tehran Branch of Azad Islamic University, Arak, Iran*
[2] Food Science and Technology, Agricultural Department, Urmia University, Amol, Iran
[3] Occupational Safety & Health Engineering, Department of Occupational Health, Hamadan University of Medical Sciences, Hamadan, Iran

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ABSTRACT
Most industries throughout the world are planning to reduce occupational illnesses, accidents, near misses, financial, and environmental losses using preventive approaches based on the human, financial, and environmental resources conservation issue. Therefore, HSE units have been established step by step in different industries and contributing to each other well-integrated. Thus, the HSE unit’s performance rate or level is significant considering their important role and it is required to be measured and reviewed regularly. In this study, lead and lag performance new technique indicators with “analytic hierarchy process” (AHP) and “key performance indicators” (KPI) were used in order to measure HSE management system performance level in a selected food products company which including three main steps: measurement criteria’s determination in three health, safety, and environment scopes using AHP technique to determine importance rate and scoring them in two lead and lag groups, calculating deviation frequency and severity parameters, reward factor in two lead and lag groups, and finally HSE management system performance level score determination in every 5 year period. The results were indicated HSE management system performance level gradual progress in meat products section of food products company in the last 5 years and showed relatively good on average progress in dairy products section. The dairy product section had better performance and faster progress trend which affected considerably due to the accident happened last year (2019) and consequently placed in weak performance level in that year. KPIs leading and lagging indicators could be used with multi-criteria decision-making methodologies to evaluate HSE management system performance while it is important to select exact indicators and categorize them into leading and lagging parts.

KEYWORDS: *HSE Management System, Performance Measurement, KPI, Lead and Lag Indicators, AHP*

INTRODUCTION

Health, safety, and environment management system (HSE-MS) is a type of modern integrated management system with a preventive approach in which human resources are the first priority of sustainable development [1]. In modern management attitude, worker's health and welfare and also environmental resources protection are considered in addition to productivity, product's quality, and customer's satisfaction. One of the major reasons for all organizations tendency to implement an HSE-MS and sustainable improvement is earning validity and value in competitive world which even could justify them to follow associated requirements including OHSAS 18001, BS 8800, ISO 14001, ISO 31001, and other instructions and regulations [2]. That is why most companies are competing with each other in order to attract more customers which require satisfied human and protected environmental [3]. In fact, modern management systems could create a connection between health, safety, and environment principles with quality insurance and management (ISO 9001). The main basis to continuous improvement and integrated HSE management is Deming Cycle which containing 4 main steps: planning in three health, safety, and environment areas, doing plans, checking plans and then acting which is repeating regularly [4]. HSE-MS is a tool for each company which can eliminate or reduce health, safety, and environment hazards at workplaces and also cause organization development to be sustainable permanently [5]. HSE management system has seven significant elements including leadership and commitment, policy and strategic objectives, organizations, resources and documentation, evaluation and risk management, planning, implementation and monitoring, and review which will improve considerably the integrated management system sections performance [6]. HSE management system quality and effectiveness are summarized to gain the targets and minimize achieving time so that system would have better performance and quality [7]. Furthermore, systematic HSE management implementation is necessary to prevent occupational diseases, accidents, near misses, and also financial and environmental losses besides continuous improvement, efficiency decrease, and also considering staff, contractors, customers, interested parties and neighborhoods health, safety, financial, and environmental resources protection [8].

Corresponding author: Farshad Kafaei
E-mail: sirvankafaei@gmail.com

Having considered the HSE management system important role, it is essential to obtain information about effectiveness and efficiency. Therefore, some usable measurement indicators should be defined to determine HSE management system's effectiveness, efficiency, and performance [9]. There are three different performance indicators to measure HSE management system performance including key result indicators (KRI), performance indicators (PI), and key performance indicators (KPI). KPIs are one of the best tools to determine indicators that could be used in order to HSE management system measurement and monitoring. In fact, KPIs assist organization to evaluate progress rate, to reach strategic targets and additionally organizations need to measure progress periodically, to determine efficiency, and performance of HSE management system [10].

MATERIALS AND METHODS

The study methodology structure concluded three main steps concluded information collection, key performance indicators determination, and measurement calculations and results comparison.

HSE Management System Study:

In the current study, to collect more information, the HSE management system in a selected food product industry in Iran firstly was selected to evaluate health, safety and, environment documents as well as to inspect workplaces and work stations. This information could primarily clarify the HSE management system situation in the selected food products industry including health, safety, and environmental strengths and weaknesses.

KPIs Introduction:

KPIs are one of the most applicable and commonly used methods for organizational performance measuring and monitoring [11]. Additionally, KPIs determine applicable actions to monitor system performance [12]. KPIs also help to review system capability to get strategic goals

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quantitatively and qualitatively [13]. All organizations utilize KPIs to make strategic goals and attain to the best performance [14]. KPIs should have six characteristics which have been indicated in Figure 1.

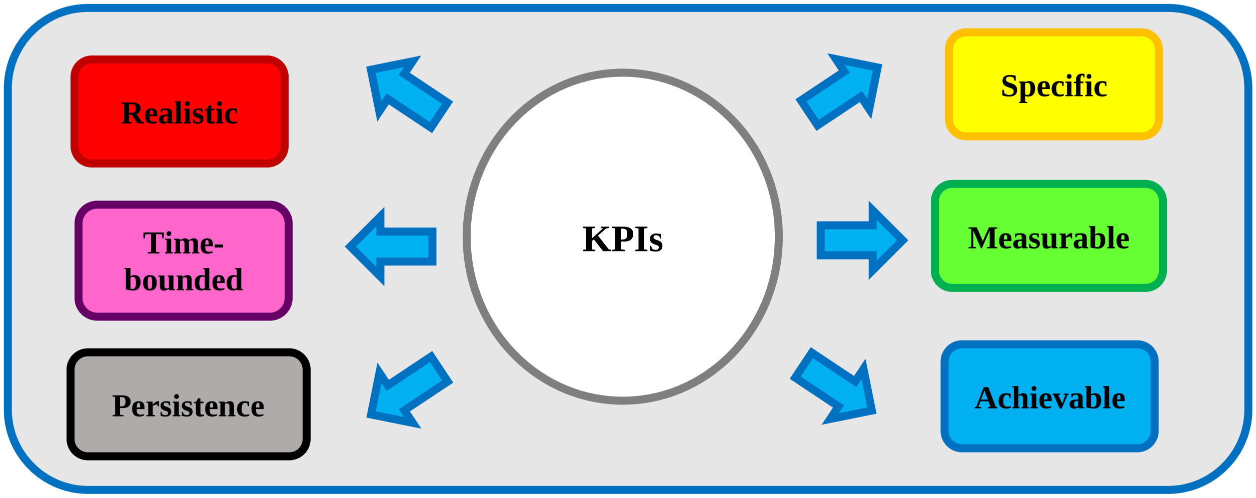

Fig 1. Characteristics of selected KPIs

Three steps including strategy planning, goals determination, and KPI definition was defined to determine KPIs as illustrated in Figure 2.

Firstly, the Cochran formula was used to calculate an ideal sample size for this study. The related equation has been presented in Equation 1.

$$n = \frac{\frac{z^2pq}{d^2}}{1 + \frac{1}{N}\left(\frac{z^2pq}{d^2} - 1\right)} \quad (1)$$

Fig 2. Three main steps of KPIs determination

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In this equation, n is the sample size, z is the abscissa of the normal curve that cuts off an area, α at the tails, p is the estimated proportion of an attribute that is the population, q is the (p-1), and d is the degree of certainty.

Numeral amounts of N=11, p=0.5, q=0.5, d=0.05 and z=5%, 10.72 were calculated for sample size based on the Cochran formula. Consequently, 10 individuals for the research team were selected including three safety specialists, two occupational health specialists, and two environment specialists for the dairy section of industry and a safety specialist, an occupational health specialist, and an environmental specialist for the meat section.

Strategies Definition:

The research team member's assistance and consultation were used to determine HSE strategies for two sections of dairy and meat products in the selected food products industry which the results have been shown in Table 1:

Table 1. *HSE strategies for dairy and meat products in the selected food products industry*

No.	Strategy description
1	To promote safety climate level
2	To establish personnel health monitoring system.
3	To increase allocated budget for environmental management system including wastes management, waste separation, entire factory pollution, and waste water purification.
4	To increase consideration to energy management.
5	To establish health, safety, and environmental management system.
6	To identify, evaluate, and assess HSE hazards and propose corrective and controlling actions.

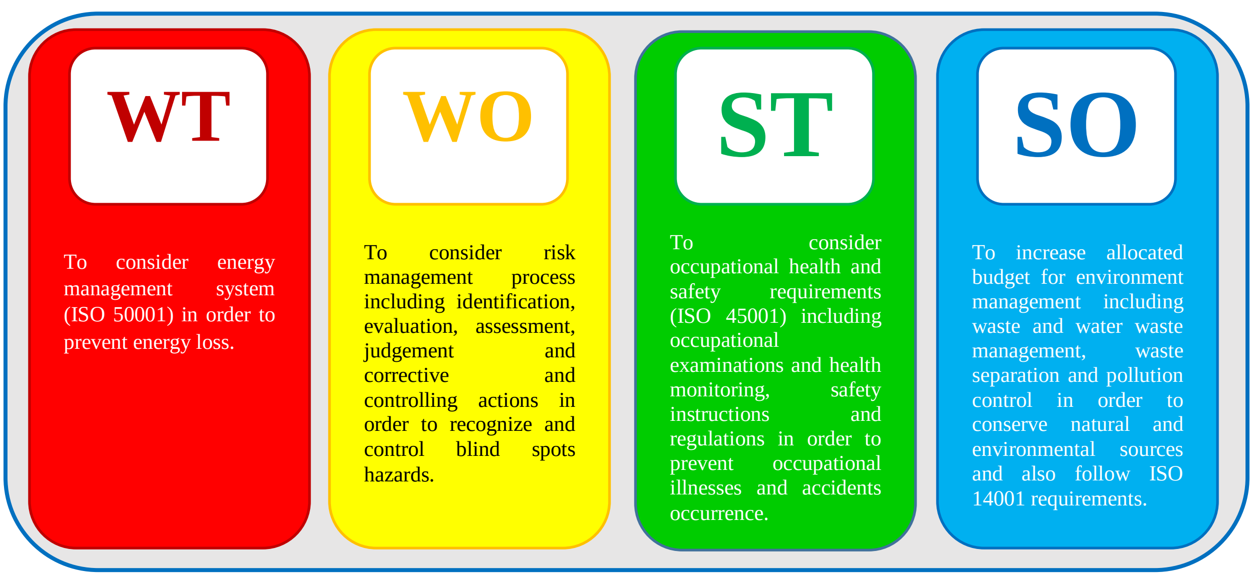

Fig 3. SWOT strategies model for selected food products industry

A SWOT strategy planning technique was applied to categorize explained strategies in Table 1 for selected food products industry based on the strengths, weaknesses, opportunity, and threats groups which have been indicated in Figure 3.

Criteria Definition:

In the next step, KPIs were determined in coordination with the SWOT strategies in selected food products industry. Besides KPIs should be measurable for specific periods of time and clearly indicates organizational performance and ability for getting determined strategies. KPIs are usually categorized into separated groups based on objectives and policies. In this study, KPIs were separated into health, safety, environmental, energy, and management systems sections according to the SWOT strategies in selected food products industry. In another study conducted by Amir-Heidari et al. [15] health, safety, security, environmental, and HSE management system defined for three similar mining industries to measure HSE management system performance which proposed to extend more criteria including risk assessment process and other criteria. In this study, two new criteria were added to others including energy and risk management system according to the SWOT strategies in selected food products industry based on ISO 50001 and ISO 31001, respectively. Although, security criteria did not have considered in this categorization, other criteria selected based on the previous studies. Consequently, seven criteria considering new categorization (HSEE) were explained as below in Table 2 [15]:

Table 2. The list of criteria [15]

No.	Criteria title
1	Health
2	Public Safety
3	Equipment Safety
4	Environment
5	Energy
6	HSE Management System
7	Risk Management System

Lead and Lag KPIs Determination:

Each selected criteria for HSE management system performance measurement had some specific KPIs which should be defined using gained information from workplaces, work stations, internal instructions, regulations, and requirements and also archived HSE documents available in selected food products industry. Additionally, brainstorm technique and consultation with research team were performed to define proper KPIs according to SMARTP characteristics. KPIs clearly indicate different aspects of each criterion which can be used for measurement process and consequently performance rate will be calculated in each area of HSE integrated management system. KPIs should be separated into two contrary groups called lead and lag to measure HSE management system performance. Lead KPIs including indicators with preventive approach and point positive side of HSE management system performance. HSE training courses, instructions, regulations and requirements, inspections and audits are simple examples of lead KPIs. On the other hand, there are lag indicators with reactive approach and negative performance side which are usually caused to accidents, damages or losses. The theory of lead and lag model KPI has been illustrated in Figure 4 to clarify model's concept.

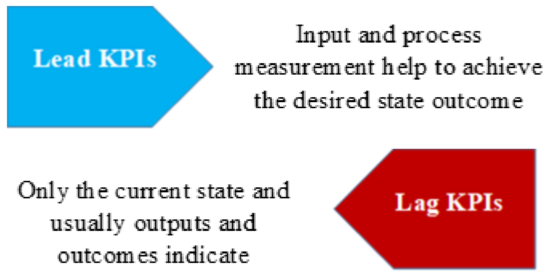

Fig 3. Lead and lag KPIs conception

The mentioned criteria should be separated into lead and lag groups in which lead and lag KPIs were defined for the next step. KPIs selection is such process which requires precision and consideration and also should be generalizable to all food products industries. Lead and lag KPIs of each criterion indicate positive and negative aspects of HSE management system performance. There are no limits for number of determined KPIs while HSE management system technology and current conditions could be effective. Numbers of selected KPIs for each criterion in selected food products industry have been listed in Table 3.

Table 3. Numbers of selected KPIs for each criterion categorized by lead and lag groups

Lead KPIs		**Lag KPIs**	
Criteria	**KPIs**	**Criteria**	**KPIs**
Health	3	Health	3
Public Safety	4	Public Safety	3
Equipment Safety	4	Equipment Safety	4
Environment	6	Environment	5
Energy	3	Energy	3
HSE-MS	5	HSE-MS	3
RMS	3	RMS	3

KPIs Weighting:

KPIs should be weighted to be used for measurement based on performance which usually performed by multi-criteria decision-making methodologies. Weighting processes help researches understand KPIs' significance and compare them to each other. KPIs comparison according to weights could lead to analyze and interpret HSE management system performance. In this study, AHP technique was used to weight determined lead and lag KPIs. AHP is one of the most commonly used multi-criteria decision-making methodologies which easily weights indicators using paired comparisons. There are two methods for weighting KPIs including AHP questionnaire and matrix which indicators are compared paired and priority scores have given by research team consultation. Matrix weighting method was used for weighting lead and lag KPIs in selected food products industry and HSE management system for performance in 2019. Lead and lag KPIs prioritization were carried out based on research team consultation and viewpoints. Additionally, super decision software was used to accelerate mathematics calculations and also to achieve higher accuracy in weighting lead and lag KPIs. The next step of lead and lag KPIs weighting regarding HSE management system performance was to select most important KPIs which prioritized with high scores. A minimum significant weight (MSW) equation, which determines scores limits for each criterion, was used to select most significant lead and lag KPIs.

$$MSW = \frac{1}{2x} \quad (2)$$

MSW equation helps researches to select the most important lead and lag KPIs for each criterion. In this equation, x is the number of KPIs' criteria which yields numerical limit which KPIs with fewer weights rather than limits, will be removed from their groups. Lead and lag KPIs weighting were performed for HSE management system performance in meat and dairy products industries in 2019. The most important selected lead and lag KPIs' results have been illustrated in Table 4 as follow [15]:

Table 4. Selected lead and lag KPIs weights for meat products section [15]

Meat products section

Lead KPIs

Criterions	KPIs	Weights
Equipment Safety	Inspection frequency of productivity equipment	0.57
	Safety instructions of productivity equipment	0.26
Public Safety	Performed tasks regarding to safety requirement	0.57
	Performed tasks under safety officers monitoring	0.26
Health	Allocated budget for occupational examinations	0.7
	Occupational illnesses management	0.22
Environment	Allocated budget for wastes management	0.4
	Wastes separation	0.12
	Allocated budget for water waste purification	0.31
Energy	Allocated budget for energy management	0.71
	Low consumption and modern equipment utilization	0.21
HSE-MS	Safety climate promotion	0.52
	Allocated budget for accidents and near miss's frequency reduction	0.19
	HSE training for workers	0.13
Risk Management System	Allocated budget for risk elimination, reduction or transfer by taking engineering and administrative solutions	0.75
	Risk assessment process	0.18

Lag KPIs

Criterions	KPIs	Weights
Equipment Safety	Accidents caused by mechanical defect of equipment	0.29
	Near misses related to equipment	0.29
	Accidents caused by explosive, flammable or toxic materials leakage in workplace	0.33
Public Safety	Near misses related to personnel	0.45
	Unsafe acts	0.45
Health	Occupational diseases	0.45
	Musculoskeletal disorders	0.45
Environment	Gasses released to the air	0.29
	Acoustic pollution	0.29
	Odorous pollution	0.29
Energy	Wasted energies	0.75
HSE-MS	Unqualified workers	0.18
	Spent budget for occurred accidents, near misses and occupational diseases	0.49
Risk Management System	Uncontrolled risks	0.22
	Unidentified risks	0.45
	Spent budget for taking ineffective actions	0.31

Table 5. Selected lead and lag KPIs weights for meat products section

Meat products section

Lead KPIs			Lag KPIs		
Criterions	**KPIs**	**Weights**	**Criterions**	**KPIs**	**Weights**
Equipment Safety	Inspection frequency of productivity equipment	0.21	Equipment Safety	Accidents caused by mechanical defect of equipment	0.32
	Performed corrective actions for equipment	0.59		Near misses related to equipment	0.48
Public Safety	Using PPE in workplace	0.26			
	Performed tasks under safety officers monitoring	0.27	Public Safety	Near misses related to personnel	0.32
Health	Allocated budget for occupational examinations	0.24		Unsafe acts	0.6
	Occupational illnesses management	0.49	Health	Occupational diseases	0.64
	Industrial psychology considerations	0.25		Musculoskeletal disorders	0.29
Environment	Allocated budget for wastes management	0.27			
	Wastes separation	0.15	Environment	Industrial water waste leakage to environment and sewage system	0.2
	Allocated budget for odorous pollution	0.16		Gasses released to the air	0.19
	Allocated budget for water waste purification	0.43		Acoustic pollution	0.19
Energy	Low consumption and modern equipment utilization	0.71		Odorous pollution	0.34
			Energy	Wasted energies	0.71
HSE-MS	Allocated budget for accidents and near miss's frequency reduction	0.47	HSE-MS	Untrained workers	0.24
	Safety and health inspections of workplace	0.23		Spent budget for occurred accidents, near misses and occupational diseases	0.66
	HSE training for workers	0.14	Risk Management System	Uncontrolled risks	0.2
Risk Management System	Identified risks in yellow and red areas	0.18		Unidentified risks	0.68
	Allocated budget for eliminate, reduction or transfer risks by taking engineering and administrative solutions	0.47			

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Performance Measurement Process:

In this section, HSE management system performance in selected food products industry was measured based on weighted lead and lag KPIs and other coefficients. Other essential factors which should be considered included MAL, MKF, DFF, DSF, Lead DI, Lag DI, Lead Reward, and Lag Reward, respectively. In fact, HSE management system performance measurement was possible when all mentioned factors were estimated which were used finally for HPI factor.

Minimum Acceptable Level:

Another factor that was estimated besides lead and lag KPIs was the minimum acceptable level (MAL). MAL indicates the lowest levels of each criterion which are were acceptable for HSE manager and experts generally and estimated according to a 5-point Likert scale illustrated in Table 6 as follow:

Table 6. MAL 5-point Likert scale

MAL				
1	2	3	4	5
Very weak	Weak	Medium	Strong	Very strong

MAL factor was usually estimated by the research team's consultation which lowest acceptable levels of each criterion were selected for lead and lag groups separately according to a 5-point Likert scale. MAL factor is one of significant performance measurement components which was considered for lead and lag performance. It should be noted that MAL for lead and lag criteria has different concepts. MAL for a lead group is meaning the lowest acceptable level of the best performance and in the other hand, MAL for the lag group has the meaning of lowest acceptable level of the worst performance on HSE manager and experts' point of view.

Missing KPI Factor:

The second considered coefficient of performance measurement process was missing KPI factor which was known as the MKF coefficient. MKF coefficient was considered for performance measurement because it is possible to ignore or miss some KPIs in the past and probably approximated which could deviate final results and this factor corrects calculation results. There are two different states of MKF indicated in Equation 2:

MKF = 0; if KPI was measured in past (2)

MKF = 1; if KPI was not measured in past

MKF was calculated 1 when some KPIs did not measure in past while should be calculated for present and for as much as KPIs were weighted between 0 up to 1 in the AHP technique, missed KPIs were estimated 1 contractually.

Deviation Frequency Factor:

The next factor for performance measurement calculations was deviation frequency (DFF). This factor indicates the deviation frequency of KPIs in comparison with their estimated MALs. DFF was considered in two different states as shown in Equation 3:

DFF = 0; if KPI value is greater than MAL (3)

DFF = 1; if KPI value is less than MAL

In this case, KPIs value is meaning worthiness which was compared with the estimated MALs of each criterion.

Deviation Severity Factor:

Another similar factor was deviation severity factor (DSF) which shows KPIs deviation rates in comparison with the estimated MALs of each criterion. There are two different states of DSF as presented in Equation 4:

DSF = 0; if KPI value is greater than MAL (4)

DSF = 1; if KPI value is less than MAL

Deviation Index:

Three mentioned indicators including MKF, DFF, and DSF were the main components of deviation index calculations. The deviation index was calculated for lead and lag groups separately to estimate the deviation rate for lead and lag KPIs. Deviation index calculations for lead and lag groups were explained in Equations 5 and.6 as follow:

$$DI_{Lead} = \left(\left(\frac{\sum_{i=1}^{n} \sum_{j=1}^{m} (MKF_{ij} \times C_1)}{(n \times m)} \right)^2 + \left(\frac{\sum_{i=1}^{n} \sum_{j=1}^{m} DFF_{ij} \times w_j \times m \times C_2}{(n \times m) - \sum_{i=1}^{n} \sum_{j=1}^{m} (MKF_{ij})} \right)^2 + \left(\frac{\sum_{i=1}^{n} \sum_{j=1}^{m} (DSF_{ij} \times C_3)}{(n \times m) - \sum_{i=1}^{n} \sum_{j=1}^{m} (MKF_{ij})} \right)^2 \right)^{½} \quad (5)$$

In Equation, 5 n is the number of years (recommended 5 years), m is lead groups KPIs number, w is KPIs weight, C1, C2, and C3 contractually were equal to 14, 6, and 5.

$$DI_{Lag} = \left(\left(\frac{\sum_{i=1}^{n} \sum_{j=1}^{k} (MKF_{ij} \times C_1)}{(n \times k)} \right)^2 + \left(\frac{\sum_{i=1}^{n} \sum_{j=1}^{k} DFF_{ij} \times w_j \times k \times C_2}{(n \times k) - \sum_{i=1}^{n} \sum_{j=1}^{k} (MKF_{ij})} \right)^2 + \left(\frac{\sum_{i=1}^{n} \sum_{j=1}^{k} (DSF_{ij} \times C_3)}{(n \times k) - \sum_{i=1}^{n} \sum_{j=1}^{k} (MKF_{ij})} \right)^2 \right)^{½} \quad (6)$$

In Equation 6, n is the number of years (recommended 5 years), k is lag groups KPIs number, w is KPIs weight, C1, C2, and C3 were the same rates mentioned for Equation 5. If HSE management system performance measurement was considered for 5 years, then the DI calculations should be carried out for each year separately.

Reward Factor:

On the contrary to the missing KPI factor, reward factors (RF) determine those KPIs which have more value rather than related estimated MAL of each criterion. A reward factor was estimated by two different statements showed in Equation 7 as follow:

RF = 0; if KPI value is less than MAL (7)

KPI value/MAL; if KPI value is greater than MAL

If KPI value was greater than MAL, KPI value should be divided to MAL value which was estimated for RF value; otherwise RF was considered 0 for calculations.

Performance Reward:

The performance reward can be calculated for lead and lag groups separately using an average reward factors for n years. This factor indicates positive side of performance for organizational HSE management system. Performance reward factor (PRF) has been explained based on Equations 8 and 9:

$$Reward_{Lead} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} RF_{ij} \times C_4}{n \times m} \quad (8)$$

$$Reward_{Lag} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{k} RF_{ij} \times C_4}{n \times k} \quad (9)$$

It should be mentioned that the coefficient C4 was equal to 2 contractually in Equation 8 and 9 for calculations.

HSE Performance Index:

HSE performance index indicates HSE management system performance for two different groups of lead and lag. HSE performance index (HPI) determines two different sides of performance for HSE management system. The calculation formula was mentioned in Equation 10 and 11:

$$HPI_{Lead} = 22 + Award_{Lead} - DI_{Lead} \quad (10)$$

$$HPI_{Lag} = 22 + Award_{Lag} - DI_{Lag} \quad (11)$$

For the last calculation step, a geometric mean method was used to estimate the total HSE management system performance using Equation 12 for that year.

$$HPI = (HPI_{Lead}^2 + HPI_{Lag}^2)^{½} \quad (12)$$

There were defined metrics that guide the research team to find out whether the HSE management system performance was acceptable or not. These metrics were designed using a fuzzy approach to categorize some numerical ranges based on qualitative groups. The mentioned metrics have been illustrated in Table 7.

HSE management system performance measurement metrics provide an indication to determine HSE performance level quantitatively and also range them into qualitative categories. This categorization included HSE performance rate for lead, lag, and total HPIs. These performance measurement metrics could indicate the HSE performance rate and compare them to each other. Accordingly, charts could be illustrated in order to compare HSE management system performance in three lead, lag, and total HPIs for the recommended 5 years of the company. Charts could easily show the condition of the HSE management system and progress or regression process.

Table 7. HSE management system performance measurement metrics

	Very weak	**Weak**	**Fair**	**Good**	**Excellent**
HPI (lead)	<10	≥10&<15	≥15&<20	≥20&<23	≥23
HPI (lag)	<10	≥10&<15	≥15&<20	≥20&<23	≥23
HPI (total)	<15	≥15&<22	≥22&<28	≥28&<33	≥33

RESULTS

HSE management system performance in selected food products industry was measured for 5 years regarding explained mathematics calculations and measurement. In addition, two similar sections of meat and dairy products were measured separately to compare each other in the last step. The results of Table 8 and 9 showed HSE management system performance rates for meat and dairy products in 2019:

Table 8. Meat products section lead and lag HPIs in 2019

Meat products section	
HPI (lead)	HPI (lag)
16.98	14.51

Table 9. Dairy products section lead and lag HPIs in 2019

Dairy products section	
HPI (lead)	HPI (lag)
13.59	14.2

Based on lead and lag HPIs for two meat and dairy products sections in 2019, total HPIs were calculated separately regarding Equation 12 and have been presented in Table 10:

Table 10. Meat and dairy products section total HPIs in 2019

Meat products section	**Dairy products section**
Total HPI	Total HPI
22.33	19.65

According to performance measurement metrics, HSE management system performance level in meat and dairy products sections were identified and have been illustrated in Table 11:

Table 11. Meat and dairy products sections HSE management system performance rates in 2019

	HPI (lead)	**HPI (lag)**	**HPI (total)**
Meat products section	16.98	14.51	22.33
Dairy products section	13.59	14.2	19.65

The outcomes of Table 11 showed that the meat products section was rather better than the dairy products section considering HSE management system performance in 2019 according to lead, lag, and total HPIs calculated rates. The results of 5-year HSE management system performance rates for meat and dairy product sections have been presented in table 12 to provide a better interpretation of HSE management system performance.

Table 12. Meat and dairy products sections HSE management system performance rates for 5 last years

Section	HPI	2015	2016	2017	2018	2019
Meat products	HPI (lead)	14.51	15.23	15.88	16.63	16.98
	HPI (lag)	13.08	12.87	13.46	14.03	14.51
	HPI (total)	19.54	19.94	20.82	21.76	22.33
Dairy products	HPI (lead)	15.22	15.78	15.9	16.75	13.59
	HPI (lag)	14.13	14.67	15.75	16.71	14.2
	HPI (total)	20.76	21.54	22.38	23.65	19.65

According to the HSE management system performance rates in meat and dairy products sections, the dairy products section had better performance relatively during the last 5 years. On the other hand, the meat products section had a continued progress in HSE management system performance while the dairy products section had a considerable fall in 2019 which was less than the meat products section HPI rate. Based on the dairy products section HSE management system condition's data in 2019, a major accident caused to reduce KPIs' weights. This major reduction has been illustrated in Figure 5. The results of 5-year HSE management system performance rates proved that the dairy products section although had better HSE management system performance totally but the meat products section had steady progress during the last 5 years. It can be concluded that a systematic and integrated HSE management performance can prevent accidents and damages effectively. An explosion caused by the steam boiler and fire spread in materials store significantly reduced HPI's rate in 2019 compared to previous years according to KPIs' calculations and estimations.

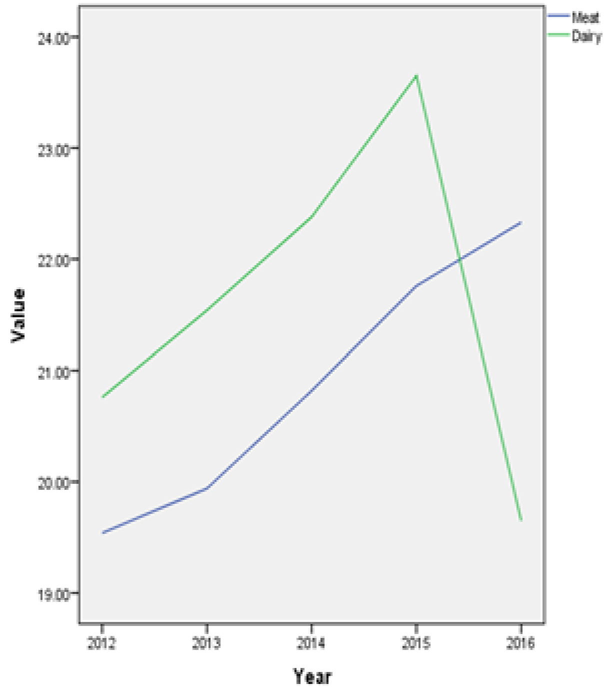

Fig 4. Meat and dairy products sections HPI rates during the last 5 years

The meat products section's HPI rates showed HSE management system performance stability that caused to improve KPIs' rates during the last 5 years. It shows that HSE hazards in workplaces can affect KPIs weights considerably. So it is recommended that HSE managers should plan some preventive programs to keep performance consistent and stable for many years. KPIs' weights were influenced by health, safety, and environment accidents and near misses. Having considered these factors, final HPI rates were changed.

CONCLUSION

HSE management system performance measurement process is one of the most important tools for periodic evaluating of HSE condition in which the processes progress or regression for many years and also weakness and strength points were specified. In addition, the effectiveness of corrective and controlling actions was determined based on the HPI's rates during the last years. These factors help HSE managers to take more preventive or even innovative plans to improve the HSE management system performance process step by step.

In the current study, KPIs were selected based on the identified hazards, evaluated risks, accidents, near misses' records, and also according to the industrial HSE strategies. The finding of this study can be extended only in similar industries from the HSE management system performance point of view. Actually, for more realistic HPIs' results other criteria or KPIs can be added to the HSE management system performance measurement process. For instance, physical, chemical, and biological adverse agents in workplaces can be considered as KPIs for health criterion which reflects real HSE performance situations. Different industries had various criteria and KPIs which should be considered for the performance measurement process. For example, process industries have more chemical and explosive or flammable materials hazards while food products industries have more health and environmental hazards. Ultimately, appropriate criteria and KPIs selection, provide more actual and accurate HPIs results.

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