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A NOVEL HYBRID METHODOLOGY FOR EVALUATING THE EFFECTIVENESS OF OCCUPATIONAL HEALTH AND SAFETY PRACTICES

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ABSTRACT

Occupational health and safety, especially with the legal arrangements enforced recently, has become a subject coming to the forefront more and more. Negligence in this regard may lead to serious material and moral results. Therefore, the fulfillment of necessary applications on the subject and the effectiveness of such applications are of great importance. In this study, the current occupational health and safety practices in the hospitality industry were examined with regards to their level of effectiveness. For this purpose, through the questionnaires administered to the employees, analytical and quantitative measurement of effectiveness was conducted by using the factor analysis and Fuzzy Rule Based System (FRB). We have analyzed not only the factors affecting the success of applications, but also the importance level of them. In addition, we have observed how the effectiveness of the activity changed when the factors were interfered. Thus, unlike previous studies, a new hybrid methodology which allows us to make numerical analysis and interpret the effectiveness of occupational health and safety practices was revealed. It is anticipated that this methodology can become a standard measurement tool to evaluate the success of these applications by means of applying them on other industries in the future.

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INTRODUCTION

Throughout history, people had to work to meet their most basic needs. This requirement led people to work at various jobs and in many different environments. In all of these jobs and environments, due to the presence of elements of danger, the protection of workers from these elements has been as important as the work itself. At this point, the concept of occupational health and safety has emerged. Although there are various definitions for occupational health and safety, a comprehensive and widely accepted definition was made in a declaration issued by International Labor Organization (ILO) and World Health Organization (WHO): "Occupational health should aim at the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities and; to

summarize: the adaptation of work to man and of each man to his job" (Özkılıç, 2005, p.5). The formation of the multidimensional safety approach in this definition was only possible after certain historic processes. Especially after the Industrial Revolution, in line with rapidly developing industry and mechanization in the early 19th century, many situations that put workers' health and safety in danger have emerged. With the addition of factors such as overly long working hours and heavy working conditions of women and children, an increasing interest has been shown to improvement of working conditions. This interest has been large enough to involve groups with socio-political approaches and unions, and has provided a basis for legal regulations (Tüzüner, Özarslan, 2011; Demirbilek and Pazarlıoğlu, 2007). Work constitutes a large part of a person's everyday life. Therefore, the provision of safe working conditions is a critical subject. According to the statement of ILO, 153 workers have an occupational accident every 15 seconds in the world and 1 worker dies due to occupational accidents or diseases every 15 seconds. This adds up to a total of 2.3 million people annually (Şoaita, 2014). Possible consequences are not limited to death, which is the worst case scenario, but also include negative outcomes such in various dimensions. According to ILO, the economic loss due to occupational accidents and diseases is more than

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4% of world's annual GDP. When physical, psychological and family-related problems experienced by workers, resulting social effects, physical and economic losses incurred by establishments, in short, many possible material and moral outcomes occurring directly or indirectly are taken into account, the gravity of this issue will be understood more clearly (Tozkoparan, Taşoğlu, 2011). Yet work accidents and occupational diseases mostly have preventable causes and if correct measures are taken, work related accidents and diseases can be reduced to a minimum. In this way, it will be possible to avoid many costs in terms of humanitarian, economic and even social dimension (Alli, 2008 p.4). Because occupational health and safety is a matter of great importance, not only economically and physiologically, but also socially (Ceylan, 2011). While the issue of occupational safety has a very large framework, workers are in the center of this subject. Therefore, workers need to show enough interest in the subject firstly. It will be possible for establishments to have a safety culture by gaining workers this interest. It is possible to talk about a bilateral relationship, since the presence of a safety culture in establishments will be an effective factor on behaviors of workers (Mat Zin, İsmail, 2012). The safety culture, which is a part of the concept of the organizational culture in establishments, means the adoption of certain safety-related attitudes by workers of each level and its resulting effects (İşler, 2013). Creating a common safety culture has an active role in accident prevention in establishments (Chib, Kanetkar, 2014). Being aware of accident that might occur during work and continuity of measures taken to prevent those accidents is only possible by introducing an established positive safety culture (Aytaç, 2011). Having knowledge sufficiently is a prerequisite for being related at desired level. At this point, occupational health and safety trainings become prominent. Trainings firstly contribute to the adoption of appropriate safety-related attitudes and ideas by workers, and then implementation of these ideas during work.

Regular trainings increase workers' knowledge and skills regarding possible risks, and thus help them pay more attention to the protection of their own physical and psychological health (Sarı, 2009). These trainings are generally held within the establishment and the contribution level of these trainings to workers depends on their continuity. Also, these trainings have even more significance especially for new and inexperienced workers. If trainings are held not only to avoid legal liability, but also to truly contribute to workers' knowledge and skills, this will constitute the most basic step to create a positive safety culture in the establishment (İşler, 2013). Especially in recent years, trainings regarding occupational health and safety have become even more prominent in strategies adopted by ILO and European Union, and relevant countries have been requested to make necessary legal regulations.

Thus, problems arising from lack of knowledge have been attempted to be minimized (Kılıkış, Demir, 2012). However, these regulations cover only the trainings held in the workplace in principle. Whereas these trainings need to be given in all levels of education, especially in institutions giving technical training. This will make it possible to raise educated and conscious generations. In addition, the quality of these trainings is directly linked with the competence of experts who will give these trainings. In this respect, instead of giving the title of specialist to new graduates or recently graduated professionals as in the existing system, training

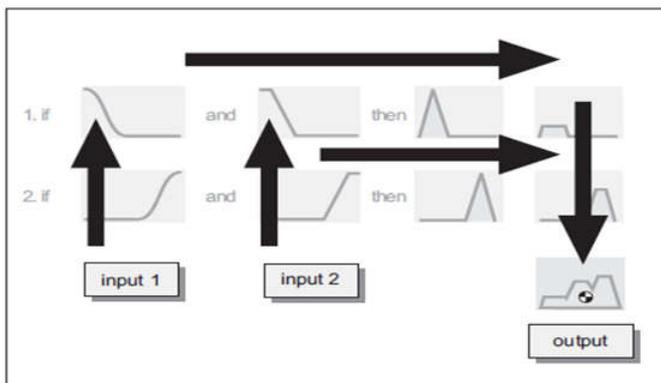
specialists through undergraduate and higher level programs, as seen in some more recent examples, will give much more positive results (Yılmaz, 2009). Considering that behavior changes resulting from these trainings are of vital importance, behavior change oriented training methods must be implemented instead of rote learning in both undergraduate and higher level programs (Ofloğlu *et al.*, 2012). Although workers constitute the key pillar of this subject, managers have a major responsibility to create safe and healthy working conditions. Just as workers, the first and most important point for managers is that the sufficient attention is given to the subject. It would be meaningless to evaluate worker safety issue without considering managers' attitude because managers' behavior has a key role in changing workers' behavior (Mat Zin, İsmail, 2012). On the other hand, performance of health and safety practices that are required in a workplace depends on managers' attitude.

Many points such as organization of practices, technologies to be used, inclusion of workers to these practices shape according to the attention and knowledge of managers (Alli, 2008 p.46). Making sure that workers are informed after determining potential risks in the working environment and taking necessary measures against these risks, that occupational health and safety trainings are held properly and that workers participate in these trainings among the prominent responsibilities of managers (Kılıkış, Demir, 2012). Taking into account that most accidents occurring in the workplace are due to lack of knowledge (Yılmaz, 2009), it is safe to say that these responsibilities of managers have a key role in the occupational health and safety performance. Performing risk analysis is another responsibility of establishments regarding occupational health and safety that needs to be emphasized. This practice, which is required for establishments by the relevant law, is the process of determining general and specific risks likely to occur during each work process of the establishment and relevant hazard levels of these risks. Performance of this analysis is a prerequisite for taking necessary measures against possible risks. As a result of the analysis, risks are classified according to level of importance and it is determined whether or not they are negligible, if not, necessary measures are taken (Atayeter, Terzioğlu, 2009). All workers must be informed about risk analysis results, if not, even though the legal liability is eliminated, the practice does not fulfill its original purpose. Moreover, risk analysis and assessment is not a one-time application. It should be performed again upon significant changes in the workplace in terms of physical properties, technology or working conditions because such changes may affect possible risks and create new risks (Hughes, Ferrett, 2011 p.101).

There are certain control mechanisms aimed at maintaining the quality and continuity of occupational health and safety practices in establishments. Some of these are inspections performed by the management of the establishments, audits performed by occupational safety specialists and official audits performed by independent labor inspectors. Official audits are performed on a regular basis by independent labor inspectors. Thus, the conformity of practices of the establishment aimed at creating a safe and healthy working environment to regulations is checked and deterrent penalties leading up to closing the establishment are exercised if necessary. However, internal audits and inspections performed frequently by occupational safety specialists may be more effective compared to official

audits because these audits and inspections involve much more intense communication with workers. It is more likely that some situations not communicated with the management are shared with occupational safety specialist and occupational health doctor. At this point, it needs to be mentioned that the communication between workers – management – occupational safety specialists / occupational health doctor is of critical importance for practices and inspections to give positive results. The purpose of this study is to identify the effectiveness of occupational health and safety practices carried out in Turkey and basic factors affecting the success of these practices. Workers' perceptions regarding this effectiveness level and affecting factors were measured. However, rather than only measuring and interpreting perceptions qualitatively, another purpose of this study is to establish a quantitative model based on these qualitative findings and generalize this model in a way that it can be applied in future. To this end, qualitative and quantitative methods were used together to develop a hybrid method that identifies the effects of the determined factors on the effectiveness level of occupational health and safety practices. The study was performed on accommodation businesses in the tourism industry.

There have been some studies on existing occupational health and safety practices in the tourism industry. However, the number of studies performing an analysis on these practices by combining both qualitative and quantitative methods is very limited. Some studies examining these practices with qualitative and quantitative methods are mentioned in this paper. Demirbilek and Pazarlıoğlu have attempted to determine factors causing occupational accidents by analyzing the data related to occupational accidents and diseases released by Turkey Social Security Institution (SSI) between 1980 and 2004. They performed one-way analysis of variance and cointegration regression analysis on the data (Demirbilek and Pazarlıoğlu, 2007). Dimitrov used a different methodology to measure occupational health and safety risks in tourism establishments. Accordingly, occupational health and safety risks are treated as a function of three different variables.



(Source: MATLAB Fuzzy Toolbox User's Guide, 2013, page 2.30)

Figure 1. The working principle of Fuzzy Rule-Based System

These variables are the probability of the risk event to occur, a score belonging to consequences in case of the risk event's occurrence, and the proximity of the risk event in terms of time (Dimitrov, 2009). Sari has investigated whether the training given to workers in the hospitality industry was effective on occupational health and safety, and reached to the conclusion that it had a very positive effect (Sari, 2009).

Ceylan has tried to identify Turkey's overall state in terms of occupational health and safety by comparing occupational accident rates of Turkey with developed countries. To make a comparison, he used the parameters of accident rate, accident frequency and accident severity rate found in the international literature (Ceylan, 2011). In his next study, he analyzed and interpreted occupational accidents based on the number of accidents, especially laying emphasis on mining, metal and construction industries (Ceylan, 2012). In their study, Sgourou *et al.* used Soft System Methodology (SSM) in order to evaluate occupational health and safety performance and support the decision between safety improvement programs. To this end, they performed a case study and came to the conclusion that this methodology could be used for the purpose of evaluating safety performance (Sgourou *et al.*, 2012). Saeed *et al.* evaluated the performance of occupational health and safety practices in the food industry through the perceptions of workers. To do so, they performed correlation analysis on the data obtained from workers with the help of a survey (Saeed *et al.*, 2014). Türen and Gökmen analyzed the correlation between deaths due to occupational accidents and the age factor, and found a significant and non-linear (quadratic) correlation between these two variables (Türen and Gökmen, 2014). In order to measure the operational performance of occupational health and safety management systems, Podgorski used the AHP method to choose prominent 'key performance indicators', (Podgorski, 2015).

MATERIALS AND METHODS

Since the purpose of this study is to analyze occupational health and safety practices in the tourism industry, Alanya district of the province of Antalya, one of the prominent tourism destinations of Turkey, was chosen as the area of application. Three-, four- and five-star hotels in and around Alanya constitute the study universe. The survey was filled by a total of 275 workers in 25 of these hotels. Although it was prepared as a likert-type, to conform with the methodology, the survey options were organized from low to high, 1 being the lowest and 5 being the highest, and questions were prepared accordingly. Excluding the questions measuring demographic characteristics, the survey consists of 30 questions. 4 of these questions measure the perception regarding fatal and non-fatal occupational accidents and diseases occurring in the establishment, while 4 of them measure the perceptions of workers regarding the effectiveness of occupational health and safety practices in the establishment. The remaining questions are aimed at identifying the factors that affect the performance of these practices. The collected surveys were subjected to reliability analysis and then factor analysis using the SPSS software. Thus, factors affecting the performance were found. Then, Fuzzy Rule-Based System (FRB) phases started. The Matlab Fuzzy Toolbox software was used for fuzzy rule-based system. Thus, a new hybrid methodology was introduced based on factor analysis and fuzzy rule-based system that allows for quantitative analysis of qualitative data.

Fuzzy Rule-Based System (FRB)

Fuzzy logic, thanks to its ability to represent variables that cannot be numerically measured such as human thoughts, has become an important tool to investigate cases that are ambiguous and without a certain definition. (Marius *et al.*, 2013) This system is fundamentally based on the concept of

fuzzy sets introduced by Zadeh in 1965. These sets, unlike the common concept of sets with objects known to certainly be elements of a set or known to certainly not be elements of a set, are sets whose elements have degrees of membership between the range of [0,1]. Therefore, these sets are characterized by membership functions. (Zadeh, 1965). The fuzzy rule-based system, however, are constituted by “if – then” rules describing the relationship between the variables with membership functions. Thanks to these rules, the system is subjected to a kind of learning. There are two types of deduction models applied with the help of fuzzy rules; Mamdani and Takagi-Sugeno models. The structure of the Mamdani model used in this study can be summarized as follows: For example, rules such as “If X = A and Y = B, then Z = C” are defined. Here, X and Y are input variables, while Z is the output variable. A, B and C are also terms of verbal nature such as “low” or “long”, represented with membership functions. After this stage, the defuzzification stage begins, since the output value is a fuzzy set. While different options are available for this, the centroid method is usually applied (Başaran *et al.*, 2011). This system introduces a mechanism that shows how the value of the output variable changes according to different values of the input variables.

In this study, the steps of the methodology used can be listed as follows;

- First of all, the perceptions of the workers regarding occupational health and safety are measured.
- Collected surveys are subjected to factor analysis to find factors affecting the effectiveness and performance factor.
- The effectiveness factor is selected as the output variable and others as input variables, and membership functions of “low – medium– high” are created for each of them.
- Then, again with the help of surveys, all possible fuzzy rules between the input and output variables are determined.
- Meaningless and contradictory rules are eliminated.
- The Mamdani deduction model is executed using the remaining rules.
- The defuzzification process is applied to the output of the model.

With this methodology, we can find not only the factors affecting the performance of occupational health and safety practices, but also how the performance of practices are affected when status of those factors change.

ANALYSIS AND RESULTS

The survey measuring the perceptions regarding the occupational health and safety practices was filled by a total of 275 workers of 25 hotels. The first part of the survey consists of questions measuring the demographical and professional characteristics of the participants. The demographical and professional characteristics of the participants are given in Table 1 and Table 2. The Cronbach's Alpha value was calculated in order to check the reliability of the scale before going on to the factor analysis using the questions in the second part of the survey. The Cronbach's Alpha value was

found to be about .90, which is quite high. Therefore, it can be said that the scale has a high degree of reliability. Then, the factor analysis was performed. To do this, first of all, the missing values, i.e. unanswered questions were given the mean value of all answered questions.

Table 1. Demographical Characteristics of the Participants

Gender n (Frequency)	% (Rate)	
Man	182	66,2
Woman	93	33,8
Total	275	100,0
Agen (Frequency)	% (Rate)	
25 andunder	99	36,0
26-35	82	29,8
36-45	69	25,1
46-55	16	5,8
56 andupper	9	3,3
Total	275	100,0
Educationn(Frequency)	% (Rate)	
Primary	102	37,1
High School	101	36,7
AssociateDegree	36	13,1
Graduate	30	10,9
Master	4	1,5
Unspecified	2	0,7
Total	275	100,0

Then, five factors explaining 58.6% of the total variability were obtained as a result of the factor analysis. The Principal Components Analysis was used as the deduction method and the Varimax method was used as the rotation method. The KMO value of the analysis was found to be 0,918, which is statistically significant. Then, the factor named “Effectiveness” was created to be used as dependent variable by averaging the questions measuring the opinions of workers regarding the effectiveness of occupational health and safety practices in the establishment. The factors created as a result of the analysis, the averages of the answers given to questions regarding these factors and the total variability of each factor together with the Effectiveness factor are given in Table 3. Here, the factor named “Ratio” shows the opinions of workers regarding the frequency of occupational accidents and diseases occurring in the establishment. The average of this variable was found to be low. According to this result, the workers stated that a low amount of occupational accidents diseases occurred in their respective establishments. Considering the average of the Effectiveness variable, it can be said that the workers found the performance of occupational health and safety practices to be on a medium level. According to the perceptions of workers, with a general expression; it was thought that the attitude of managers, audits, trainings and risk analyses affected the establishment's occupational health and safety performance on a medium level. However, more detailed information was obtained after the execution of Fuzzy Rule-Based System. Examining to what degree the factors explained the variability, it is seen that the Management & Inspection factor was the most effective factor. Questions measuring these two variables were brought together under a single factor. This factor explaining 19% of the total variability is the factor that demonstrates how effective the attitude of the management towards occupational health and safety and audits were on the occupational health and safety performance according to the workers. The Training factor, which was another effective factor, is the factor that demonstrates how effective occupational health and safety trainings were according to the workers.

Table 2. Professional Characteristics of the Participants

		Department									Total
		Front Office	Housekeeping	Food&Beverage	Technical	Garden	Laundry	Security	Accounting	Other	
Working Time	0-2 year	15	27	31	3	0	5	4	1	8	94
	3-5 year	5	11	29	1	1	0	3	3	4	57
	6-10 year	12	15	16	1	4	2	0	4	8	62
	11-20 year	5	13	20	4	1	0	0	2	7	52
	21 + year	0	0	3	0	0	0	0	0	3	6
Total		37	66	99	9	6	7	7	10	30	271

Table 3. Determined factors

Factor Name	Mean	Description Rate of Variability (%)
Effectiveness	3,2973	-
Ratio	1,7575	9,439
Management&Inspection	3,3747	19,048
Training	3,3515	12,570
Personnel	3,2121	9,225
Risk Analysis	3,2470	8,346
		Total : 58,627

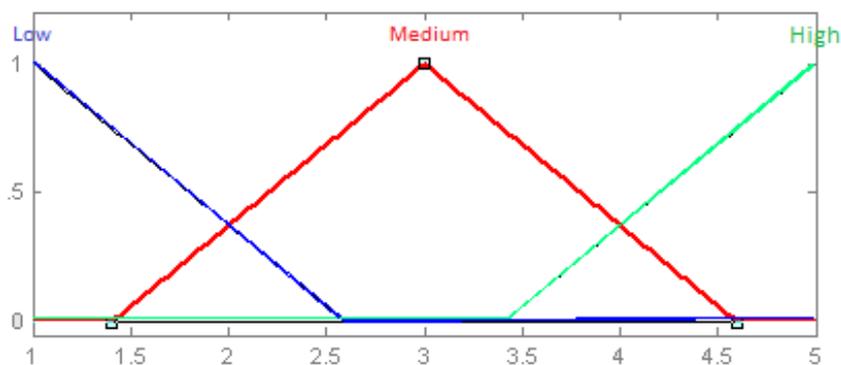


Figure 2. The membership functions showing the low, medium and high levels for the factors



Figure 3. Output of the System

The Personnel factor demonstrates the attitudes of all workers in the establishment towards occupational health and safety and the effect of these attitudes on opinions regarding the success of relevant practices. The Risk Analysis factors demonstrates the opinions of the workers to what degree the risk assessments performed in the establishment were taken into account and to what degree these assessments reflected on the practices. After this stage, the correlation between the factors was examined. Taking into account their correlation with the effectiveness variable, training, personnel, risk and

management & inspection variables were selected as input variables for the Fuzzy Rule-Based System, which was the next stage. The next step was the determination of membership functions for input and output variables selected for the Fuzzy Rule-Based System. These membership functions constitute the entry point of the concept of "fuzzy" to the system. The effectiveness was selected as the output variable, while personnel, training, risk and management & inspection were selected as input variables. Each of these variables were explored with a different number of questions. Therefore, the

arithmetic average was taken for each variable through the answers of questions measuring that variable to reduce the answers to [1,5] interval, in other words, the answers were standardized. Then, the membership functions representing the low, medium and high levels for this interval were determined. The Fuzzy Toolbox add-on of the Matlab software was used for this process. Membership functions have a triangular form. Since all variables were in a standard interval, the same membership functions were used for all of them. Determined functions can be shown as follows. Here, the color blue shows the membership function belonging to a "low" level, the color red shows the membership function belonging to a "medium" level and the color green shows the membership function belonging to a "high" level. The maximum method was preferred to determine to which group a given value belongs. In other words, depending on in which membership function the variable corresponded to a higher value, it was accepted to belong to that group. For example, if the average of answers to questions regarding the training variable is 1,6 in a survey, this value has the membership for both "low" and "medium" levels. However, since its value in the "low" membership function is greater than its value in the "medium" membership function, this answer is accepted as "low". Similarly, if the value of the variable is 3,8, because this value has a greater value in the "medium" membership function compared to the "high" membership function, it is accepted as "medium". Intersection points of the variables were included in the higher group, i.e. the value of 2 is accepted as "medium" and the value of 4 is accepted as "high". The next stage is the creation of rules for the fuzzy system. At this stage, rules that determine at what level the output will be when each input variable is at a certain level are created. The following rules can be given as examples;

- If the personnel variable is at "high", the risk variable is at "medium", the training variable is at "low" and the management & inspection variable is at "medium" level, then the effectiveness variable is at "medium" level.
- If the personnel variable is at "high", the risk variable is at "low", the training variable is at "medium" and the management & inspection variable is at "high" level, then the effectiveness variable is at "high" level.

In order to determine these rules, each survey is examined and the valid results for that survey are defined as a rule. Then, meaningless and contradictory ones among all these combinations are eliminated. Thus, the remaining rules are determined as the rules of the system. After the necessary elimination, a total of 34 rules were obtained in this study. After the determination of the rules, each rule was entered into the system and the results were obtained using the Mamdani deduction model. The output of the system at its final stage is as follows;

As seen in the output, the system created a column for each input variable and finally the output variable and put the graphs belonging to the rules on the rows. Also, it is possible to change the value of each variable by moving red stripes on each column horizontally and observe how it affects the effectiveness. For example, in the case seen in the output, the personnel and training factors are relatively low, while the risk and management and inspection factors are relatively high, thus, the effectiveness is observed to be at a medium level.

This case can be interpreted as the low level factors and high level factors balanced the effects of each other.

DISCUSSION

Trials were made with various combinations for different levels of factors on the system output and the change in effectiveness was analyzed. First of all, it was observed that the effectiveness was at a medium level when the input variables are at a medium level. The same applies to low and high levels. So, it can be said that the system established did not conflict with the predicted consequences. The real purpose of this system is to determine whether factors selected as input had any effect on the performance of occupational health and safety practices, which was the output variable, and the level of effectiveness. In order to examine this, the value of each input variable was changed in low – high direction while the values of other variables maintained, and it was observed whether there was a change in the effectiveness. Changes in each of the training, risk analysis and management & inspection variables did not have any effect on the effectiveness when other variables were maintained at the medium level. This can be interpreted as that none of these variables has the potential to increase or decrease the effectiveness by itself. However, a different result was observed for the personnel variable. When other variables were maintained at the medium level, changing the personnel variable from low to medium level did not have any effect on the effectiveness; but changing the personnel variable from medium to high level resulted in a sharp change in the effectiveness from medium to high level. Changing the personnel variable to the highest level while maintaining all other variables resulted in the highest level of effectiveness in the system. Therefore, the positive change the personnel variable has the potential to increase the performance of occupational health and safety practices by itself. However, this result does not mean that other variables are ineffective. When all variables were maintained at the maximum level and consequently the effectiveness was at the maximum level, it was observed that reducing any variable to the medium level caused the effectiveness to drop to the medium level. In other words, when any one of the variables is at the lowest level, the effectiveness cannot pass the medium level even if all other variables are at the highest level. That is to say, each variable has the ability to reduce the effect of other variables. Therefore, each variable has a certain degree of importance to increase the performance of practices and none of them should be ignored to increase the effectiveness of practices. In order to achieve successful practices, first of all, each of these variables must be improved up at least to the medium level. However, this is not the sufficient condition. For truly effective practices, variables must be brought up to the high level.

Conclusion

In this study, we analyzed the effectiveness of occupational health and safety practices in hospitality establishments. We first determined the factors affecting the success of those practices using the surveys filled by the workers. We then analyzed which factors were effective at what level using the Fuzzy Rule-Based System. With this approach, we demonstrated the factors that must be addressed as a priority in order to increase the effectiveness of practices. Ultimately, it was found that each of the variables obtained was an effective factor to increase the performance of occupational health and

safety practices according to the perceptions of the workers. However, at this stage, the attitude of the workers is one step ahead. Giving occupational health and safety trainings in the establishment and increasing the quality of these trainings, performing risk analyses and taking results into account, sensitivity of the management to the subject are decisive factors for the occupational health and safety performance of the establishment, but the sensitivity of the workers is the factor that determines the result. Attention and sensitivity of workers as the basic unit of the subject is the prerequisite for the success of all other factors. Therefore, before technical trainings, it is of vital importance to hold awareness programs to gain workers the required sensitivity. It is also necessary to strengthen the communication between workers and the management and taking their opinions into account. This way, it will be possible to turn workers into the most active unit to create safe working environments. Unlike earlier studies, this study has introduced a methodology based on workers' perceptions, but also has an analytical systematic to analyze the effectiveness of occupational health and safety practices. Most of the studies available in the literature are qualitative and depends on the interpretation of perceptions. The methodology depending on statistical analysis introduced in this study is thought to have provided a different perspective to the literature. We believe that this methodology applied on hospitality establishments can be expanded for other industries and units in future studies and become a standard tool to measure the effectiveness of occupational health and safety practices.

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