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Application of the theory of planned behavior in the design and implementation of a behavior-based safety plan in the workplace

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Abstract:

BACKGROUND: Many accidents in industries occur due to unsafe practices and unsafe conditions. Occupational accidents endanger the health of workers and impose excessive costs on the employers. This study was designed and conducted to evaluate and implement a behavior-based safety approach in an industrial workplace based on the theory of planned behavior.

MATERIALS AND METHODS: The present study was a quasi-experimental study performed on 90 supervisors of an industrial workplace. Behavior-based safety interventions were performed based on the components of the theory of planned behavior using nine strategies of health education and health promotion, including skills training, participation, and social support. The data collection tool consisted of a researcher-made questionnaire that was answered by the supervisors before and 6 months after the intervention. The collected data were evaluated using SPSS 22 software. The significance level was considered 0.05.

RESULTS: The results showed that the constructs of subjective norms, attitude, and perceived control of behavior predict the safe behavior of supervisors. After behavior-based safety interventions, significant changes were observed in subjective norms, intention, attitude, and perceived control of behavior ($P < 0.001$) compared to before the intervention.

CONCLUSION: The results of this study showed the improvement of safe behavior of supervisors in the workplace due to behavioral-based safety interventions using the theory of planned behavior. Accordingly, this theory can be used as a suitable theoretical framework for designing and implementing interventions to promote safe behaviors of employees in the workplace.

Keywords:

Behavior-based safety, healthy workplace, planned behavior model

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Introduction

Preservation of workforce and attention to the health of the labor force are considered as the basis of economic growth of countries. Improving working conditions, designing equipment, and working methods in accordance with the behavioral and functional abilities of individuals can reduce the possibility of errors and inappropriate behaviors of individuals in different work

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situations and can provide a safe work environment for the workforce.^[1] Previous studies have identified humans and the occurrence of unsafe behaviors in the face of various work situations as the most important cause of accidents in the workplace so that more than 80% of accidents in the chemical and petrochemical industries are caused by human error in the workplace.^[2-4]

Behavior-based safety is one of the concepts used in promoting safe behaviors of

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employees in which instead of examining the individual behavior of each person, his behavior is evaluated in a set of desired situations and in interaction with other factors. In such circumstances, safety experts have considered the impact of environmental factors in changing human behavior as the most important cause of injuries and damages.^[5] Behavior-based safety attitude identifies and modifies behaviors that are effective in the occurrence of occupational accidents.^[6] Behavior-based safety is an approach that, by considering the organizational and social infrastructure of behaviors, reduces the unsafe behaviors of people in different work situations through a reward system. In such an approach, more attention is paid to motivating and rewarding people to reinforce safe behaviors. To achieve this goal, the emphasis is placed on staff training, prioritizing target behaviors, recording observations of safe behaviors of employees by their peers and supervisors, employee participation in designing and implementing the intended program, and providing feedback.^[7,8]

Improving safety conditions in various industrial activities requires increasing the level of awareness, changing staff attitudes, and changing safe behaviors in the workplace. Among these, the role of behavior-based safety interventions is of great importance in promoting safety and reducing accidents. Extensive and continuous implementation of personnel training programs has a double effect in reducing accidents because in addition to increasing the level of skills in performing activities based on safety methods and criteria, it strengthens the morale and self-confidence of the personnel.^[9]

Selecting and applying the appropriate model and theory increases the chances of changing the desired behavior and helps safety experts and specialists in selecting the appropriate target group for interventions, strategy development, and preparing training materials.^[10] One of the theories used to predict individual behavior in many situations is the theory of planned behavior that predicts the intention of a person to perform a behavior. This model was introduced in 1975 to predict and explain the behavior of individuals and was developed through adding the perceived control factor by Aizen based on behaviors that are not under the voluntary control of individuals and he called it the model of planned behavior.^[11] According to this theory, the intention of the person is the most important factor in determining a person's behavior so that if it is not possible to measure the actual behavior of a person, the intention of the person can be used as a useful indicator that is influenced by three factors including attitude to the behavior (positive or negative evaluation of behavior), subjective norms (perception of the person of the likely views of other influential people about the behavior), and perceived behavior control (people's belief in the ability

to control behavior) [Figure 1].^[12] The present study designs and implements safe behaviors of supervisors in industrial workplaces by considering the mentioned structures as predictors of safe behavior in supervisors.

Materials and Methods

The present study was a quasi-experimental study on a group with the aim of changing the safe behavior of supervisors of an industrial workplace in 2017–2018. In this study, 90 supervisors were selected using the census method. The inclusion criterion was having at least 3 years of work experience in supervising different parts of that industrial unit. Before beginning the study, the goals and methods of work were explained to the participants in the study and informed consent was obtained.

Ethical considerations

The present study was approved by the Research Council of Iran University of Medical Sciences with code of ethics IR.IUMS.REC 1397.176. The questionnaires were anonymous and the purpose of the research was stated to the participants in the research. They were assured that their information is confidential and will be used only for the purposes of the research, and finally, their results will be published in general. Before intervention, written consent was obtained from the participants in the study and was completed face to face.

Figure 2 shows the steps of the study in the selected industrial unit.

Phase I: situation analysis

Through examining the documents and history of occupational accidents in the organization, it was found that the unsafe behaviors of supervisors in planning and adequate safety monitoring of work performance had the greatest impact on the occurrence of accidents. Therefore, the supervisors of different parts of the industrial unit were selected to implement a behavior-based safety plan. To identify the factors affecting the unsafe behaviors of supervisors

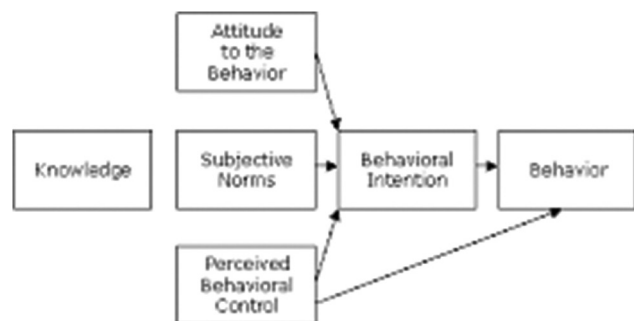


Figure 1: Scheme of the theory of planned behavior^[12]

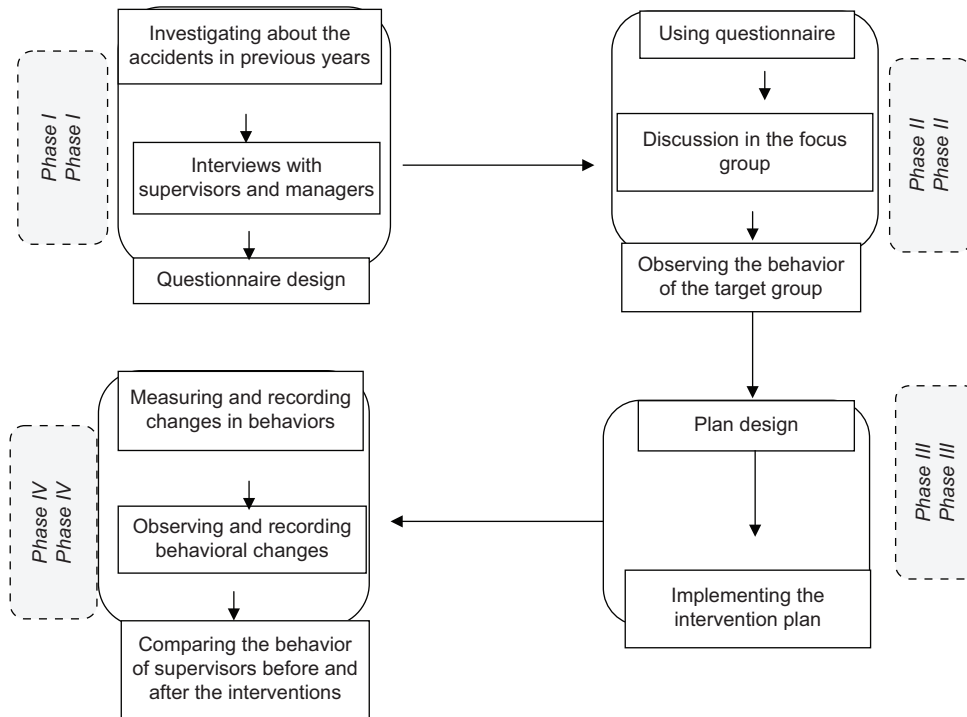


Figure 2: Steps of conducting a behavior-based safety study using a planned behavior model

and to plan and monitor executive interventions, brainstorming sessions, focus group discussions, and semi-structured interviews were used with 15 supervisors, unit managers, and safety officers of the organization. The results of this step determined the components of the supervisors' behavior that were categorized by the research team as the level of attitude, control belief, intention, and subjective norms. Due to the compliance of these components with the theory of planned behavior, this model was used in designing and implementing a behavior-based safety program. Therefore, based on the theory of planned behavior, the researcher-made questionnaire was developed and validated using the findings of a review of texts and interviews with supervisors and managers.

Questionnaire validation was determined using quantitative content validity, and content validity ratio (CVR) (necessity or nonnecessity of each question), content validity index (CVI) (relevance, clarity and simplicity of each question), and impact scores were determined, and finally, the results were applied in the questionnaire. Based on the opinions of a panel of experts including ten people specializing in safety health education, occupational health, engineering^[13], and workforce management, content validity index (CVI) and content validity ratio (CVR) of each item were evaluated. Cases with a CVR of lower than 0.62 and a CVI of lower than 0.78 were excluded from the study.^[14] In the present study, the CVI and CVR scores were 0.82 and 0.78, respectively.

Cronbach's alpha was used to estimate the reliability and it was considered to be >0.70.^[15,16]

Data collection tools

In order to evaluate the behavior-based safety in the workplace, a demographic questionnaire as well as a questionnaire based on the theory of planned behavior were filled in. Demographic questionnaire included age, education, marital status, position, and work experience.

Questionnaire is based on the constructs of the theory of planned behavior, including attitude to behavior, including 12 questions with a 5-point Likert scale (strongly agree... strongly disagree). The minimum score was 12 and the maximum score was 60, and questions such as (I think working groups can start their work before the supervisor visits the site) were used.

Subjective norms including 14 questions with a 5-point Likert scale (Strongly agree... Strongly disagree) were used. The minimum score was 14 and the maximum score was 70, and questions from refinery managers such as I believe that a work permit can be issued before visiting the site were used. Cronbach's alpha for this scale was 0.79.

Control belief included 15 questions with a 5-point Likert scale (strongly agree... strongly disagree). The minimum score was 14 and the maximum score was 70, and questions such as it is my responsibility to establish all the necessary conditions to save the lives

of subordinates in the unit were used. Cronbach’s alpha for this scale was 0.85.

Behavioral intention included four questions with a 5-point Likert scale (absolutely probable... not at all probable). The minimum score was 4 and the maximum score was 20, and questions such as how likely are you to prioritize tasks before issuing permits in the next few weeks were used. Cronbach’s alpha for this scale was 0.83.

Behavior included four questions with a 5-point Likert scale (always... never). The minimum score was 4 and the maximum score was 20, and questions such as do you prioritize the daily tasks of the unit under your supervision? were used. Cronbach’s alpha for this scale was 0.77.

Awareness questions included eight questions with a Yes or No answer, with a score of 1 for Yes and score of 0 for No. The minimum score for this part was 0 and the maximum score was eight, and questions such as the supervisor is responsible for accepting and performing all the work in the area under his supervision were used. Cronbach’s alpha for this scale was 0.77.

Phase II: Needs assessment

At this stage, a behavioral needs assessment was performed using questionnaires designed in the first phase, as well as interviews and group discussions with supervisors and managers of all working units. All components affecting safe behavior including awareness, intention, attitude, subjective norms, and perceived behavioral control were examined [Table 1].

Phase III: Execution of the intervention

According to the results of the first and second phases of the study, the components of attitude, subjective norms, and perceived behavioral control can predict the safe behavior of supervisors. Accordingly, behavior change strategies were determined, designed, and implemented as follows: [Table 2].

Table 1: Predicting the safe behavior of employees based on the constructs of the planned behavior model

| Behavior predicting variables | B | SE | β | T | P |
|-------------------------------|--------|-------|--------|--------|--------|
| Constant | -9.119 | 4.599 | - | -9.983 | 0.051 |
| Intention | 0.590 | 0.141 | 0.197 | 4.190 | <0.001 |
| Attitude | -0.210 | 0.071 | -0.135 | -2.948 | 0.004 |
| Subjective norms | 0.332 | 0.025 | 0.772 | 13.392 | <0.001 |
| Behavioral control | 0.114 | 0.039 | 0.160 | 2.942 | 0.004 |
| Awareness | -0.002 | 0.155 | -0.001 | -0.013 | 0.990 |
| R | | | 0.941 | | |

SE=Standard error

This intervention was designed with the participation of all stakeholders. After assessing the needs and identifying the key people affecting each activity, face-to-face meetings were held at their workplace to receive their opinions and gain their full support in the optimal implementation of the program. Furthermore, 12 promotion programs were designed and implemented with the participation and cooperation of stakeholders and consisted of division of responsibilities, schedule, start and end time, and the amount of required budget.

Phase III: Evaluation

Six months after the intervention, the questionnaire was refilled by the participants and they were re-analyzed.

Data analysis

In this study, SPSS 24 software (SPSS Inc., Chicago, IL, USA) on a Microsoft Windows-based computer. was used to analyze the collected data. The hypothesis of normality of the data was tested using the Kolmogorov-Smirnov test. Data had a normal distribution, so descriptive (frequency, mean, and standard deviation) and analytical tests (paired t-test and linear regression) were used. A significance level of 95% was considered in the analysis of variables.

Results

Table 3 shows the demographic characteristics of the participants in the study. Accordingly, the mean age of men in the target group was 36 ± 4.2.

Findings from the regression test showed that the components of subjective norms, perceived behavior control, intention, and attitude had a significant relationship with the safe behavior of supervisors (P < 0.05). However, the education component did not have any significant effect on the safe behavior of the studied supervisors (P = 0.990) [Table 1].

The results showed a significant relationship between mean scores of the original components of the model such as behavior, intention, attitude, subjective norms, and perceived behavior control before and after the behavior-based secure intervention (P < 0.001)[Table 4].

Discussion

Accurate identification of unsafe behaviors and taking effective measures to improve behaviors using health promotion strategies is the first step in implementing plans to improve the safe behaviors of employees.^[17] The present study aimed to design and implement a behavior-based safety plan to change the behavior of supervisors in an industrial workplace.

Table 2: Program of safe behavior-based interventions based on the theory of planned behavior

| Intervention construct | Strategy | Method of implementation of the plan | Target group |
|--|--|---|---|
| Attitude | Information mobilization | Environmental advertising | All employees |
| | | Distribution of training pamphlets, posters, banners | Supervisors |
| | Training | Preparation and distribution of training media Holding a training class for discussion in the focus group (role and responsibilities of the supervisor in ensuring workplace safety) | Supervisors and families Forty supervisors who had less participation in the program |
| Subjective norms | Expressing experiences and learning lessons | Speech of injured workers volunteering to cooperate | Forty supervisors who had less participation in the program |
| | | Focus group discussion on the topic of accidents caused by improper implementation of permits | Forty supervisors who had less participation in the program |
| | Involvement of directors and supervisors | Forming peer groups | Supervisors |
| Control of perceived behavior | Attracting the full support of managers | Managers' evaluation of the performance of permits in units | Supervisors |
| | Getting the support of families | Safety Culture Festival | Employee families |
| | Providing behavioral patterns | Visit of peer groups of units | Supervisors and heads of units |
| | | Managers evaluation of the performance of permits in units | Supervisors |
| | Showing new norms | Visit of peer groups of units | Supervisors and heads of units |
| | | Managers' evaluation of the performance of permits in units | Supervisors and heads of units |
| | Self-feedback | Safety Culture Festival Recording and submitting statements of permitting issuance behaviors | Employee families All supervisors |
| Teaching work skills with peer/foreman/supervisor permit | Permit training by peer instructors | Eighty supervisors with low participation or offending supervisors | |
| Behavior | Providing positive reinforcement of behavior | Providing incentives to foremen and mechanical supervisors with more involvement in the peer group | Supervisors |
| | | Providing incentives to supervisors who submitted the largest number of statements in the group | Supervisors |
| | | Encouraging supervisors to participate in the peer group/sending statement/training | Twenty supervisors who had the highest participation permit |
| | Skills training | Training by an expert | Twenty uncooperative/offender supervisors |

The findings of the present study showed that interventions based on the theory of planned behavior can be effective in creating safe behavior of supervisors. The findings of the present study are consistent with other studies that show the effectiveness of the theory of planned behavior in nutritional behavior,^[18] energy savings in the workplace,^[19] use of appropriate vehicles to reduce air pollution,^[20] following the treatment,^[21] infant nutrition,^[22] and physical activity.^[23]

Based on the results of the present study, the design of behavior-based safety intervention using the theory of planned behavior had a significant effect on increasing the mean scores of supervisors' attitudes. Findings of the study by Fogarty and Shaw showed that a person's attitude is effective in changing behavior.^[24] Using various training programs and facilitating safe behavior in the workplace can be the beginning of

laying the groundwork and changing safe behavior in the workplace.

The findings of this study showed a significant increase in the scores of subjective norms after the intervention in supervisors, which indicated the level of social support of those around the individual. The study by Meng *et al.* showed that the presence of monitoring and confirmation of behavior by supervisors leads to the improvement of the desired behavior.^[25] In addition, the findings of Almeida *et al.* study indicate a significant effect of subjective norms on the occurrence of safe behaviors.^[26] To be more precise, to gain the support of important people and coworkers in the organization, the person avoids some behaviors and tries to perform some behaviors. Therefore, gaining the support of influential people in the workplace can be considered as an effective intervention in adopting the safety behavior of supervisors.

The findings of this study showed that after performing behavior-based safety interventions using the theory of planned behavior, a significant increase in perceived behavioral control was created. More precisely, a person’s ability to control circumstances and behavior can increase their efforts to improve safe behavior. The findings of the present study were consistent with the results of a study by Greaves *et al.*, who found that training and participation in behavior planning and situation control were effective in increasing safe behavior.^[27] Therefore, creating opportunities to increase the ability to control behavior can be a turning point in improving the safe behavior of people in the workplace.

The results of this study show that behavior-based safety interventions using the theory of planned behavior cause a significant change in the mean score of intention to perform a behavior. This finding is consistent with the study of Gao *et al.*, who showed the effect of components of the theory of planned behavior on a behavioral intention that can ultimately lead to behavior change.^[19] Using different plans to change the intention and providing environmental conditions and factors has a great impact on changing behavior. Based on the present study and previous studies, changing attitudes, abstract norms, and perceived control can be important factors in changing behavioral intention that leads to behavior change.

Table 3: Demographic characteristics of the participants in the study

| Variable | n (%) |
|------------------------------|---------|
| Education | |
| High school diploma | 11 (12) |
| Associate degree | 29 (32) |
| Bachelor’s degree and higher | 50 (56) |
| Supervisor | |
| Beneficiary | 35 (39) |
| The mechanic | 55 (61) |
| Work experience (years) | |
| <10 | 5 (6) |
| >10 | 85 (94) |
| Marital status | |
| Single | 2 (3) |
| Married | 87 (97) |

Table 4: Comparison of the component means of the theory of planned behavior before and after the plan implementation by the administrators

| Variable | Mean±SD | | T | P |
|------------------------------|---------------------|--------------------|--------|--------|
| | Before intervention | After intervention | | |
| Intention | 14.00±1.26 | 16.17±2.3 | -5.555 | <0.001 |
| Attitude | 48.98±2.14 | 59.08±4.99 | -6.695 | <0.001 |
| Subjective norms | 41.19±6.97 | 67.77±4.95 | -6.794 | <0.001 |
| Perceived behavioral control | 54.35±5.24 | 88.49±4.824 | -3.953 | <0.001 |
| Behavior | 8.41±3.9 | 15.98±2.8 | -6.65 | <0.001 |

SD=Standard deviation

In this study, after performing behavior-based safety interventions using the theory of planned behavior, significant changes in the final behavior of supervisors were observed. The studies by Mohammadfam *et al.* also found that different training methods were effective in changing the safety behavior among workers, which is consistent with the findings of the present study.^[28]

The findings of this study show that at the beginning of the study, the level of knowledge of the target group about performing the target behavior was high, but the behavior score was not optimal. Therefore, it can be concluded that having only knowledge and information cannot be effective in adopting the behavior. However, a study by Beseler and Stallones showed that a change in consciousness caused a change in behavior, which is not consistent with the results of the present study.^[4] Using different appropriate promotional programs for the target group was one of the innovations of this study. Detailed assessment of the status que, interview, and filling in questionnaires before the intervention were the strong points of the present study. The limitations of this study were the limited study time, intervention only on supervisors, and lack of control group. It is suggested that in future studies, the managers of the organization be considered as the study group.

Conclusion

The results of this study showed that a behavior-based safety program should be carefully designed and implemented using a planning behavior model to provide a sufficient evidence-based program to change unsafe behaviors in the workplace. The use of theories such as the theory of planned behavior can help industry professionals to more accurately identify the individual and social contexts that shape behavior. This can lead to better implementation of programs to form safe behaviors in employees and its continuation, and by reducing the number of work-related accidents and reducing injuries, leads to the development of a healthy work environment.

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Conflicts of interest

There are no conflicts of interest.

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