ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 7, Issue 7 , July 2020

Safe Work Identification for Construction using Weka tool and Artificial Neural Network

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ABSTRACT: A model has been developed employing an artificial neural network (ANN) to predict the safe work behavior of employees using 12 safety climate constructs determined through literature review. The model utilizes safety climate constructs (determinants) as inputs and safe work behavior as an output. We have collect around 60 different survey reviews from end users or site owners. A three-layer feed-forward back-propagation neural network (12-12-1) was appropriate in building this model which has been trained, validated, and tested with sufficient data sets. In this research work, first we collect a survey data from different sites with multiple questionnaires related to safe behavior during the construction. This initial survey denotes the twelve different factors that can be required for safe work in construction project. During this survey we asked around 49 to 50 different questions to the site supervisor project manager as well as employees. The surveys show the rating to each factor as per the current scenario and requirement. The collected we evaluate from for WEKA using ANN feed forward approach. Once process whole data it can be generate the distance weight after the testing, and finally we rank the all parameters using ANN weight. The final section of project is focus on recommendation which parameters are important for safe behavior as work in construction.

I. INTRODUCTION

Artificial neural network (ANN) is a mathematical model for predicting system performance inspired by the structure and function of human biological neural networks. The ANN is developed and derived to have a function similar to the human brain by memorizing and learning various tasks and behaving accordingly. It is trained to predict specific behavior and to remember that behavior in the future like the human brain does. Its architecture also is similar to human neuron layers in the brain as far as functionality and inter-neuron connection. ANN has been successfully used in various applications. The life of heritage building is also more than the any other RCC buildings. The knowledge of previous treatments in cultural preservation becomes more important in conservation. To avoid implementation of an improper conservation strategy and/or evaluate suitable re-conservation, suitable materials should be chosen and criteria should be adopted. The conservation professional must strive to select methods and materials that, to the best of current knowledge do not adversely affect cultural property or its future examination, scientific investigation, treatment, or function‖. By using artificial neural network tool calculating the age of heritage building. For this ANN tool input parameters are required. An expert system is relying on human experts existing knowledge based on set up knowledge system; the expert system develops the earliest, the most effective in the artificial intelligence research field. The expert system is widely used in road and bridge, construction engineering, geotechnical engineering, underground engineering, disaster prevention project, material engineering, geological exploration and petroleum chemical industry, and so forth. The application of artificial intelligence simulates human experts in solving the problem of the thinking process in the field and reaches or approaches the level of experts.

II. LITERATURE REVIEW

Rafiq.M.Choudhry, Dongping, Fang, Sherif, Mohamed [1] presents a robust conceptual model that has its roots firmly entrenched in pertinent academic and applied literature. This study revealed a conceptual model that recognizes human, technical, situational, and organizational elements as well as their interactions. The model is anchored in three fundamental conceptual categories, namely safety climate, behavior-based safety, and safety system. The results of this

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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study clearly indicate that the model serves as the logical basis for determining what and how to analyze and assess the different aspects of construction safety culture. It offers the opportunity to adopt a goal-setting paradigm by pursuing multiple sub goals. This gave them the conclusion that Employee perceptions, safety behaviors, and environmental or situational features could be accessed through safety climate surveys, peer observations, and systems audits/inspections.

Keith.R.Molenaar; Jeong-Il. Park; Simon.Washington [2] presents the results of a structural equation model SEM that describes and quantifies the relationships between corporate culture and safety performance. The SEM and the latent variables describe to constitute a powerful framework for defining, measuring, and improving upon corporate safety culture. The SEM is estimated using 196 individual questionnaire responses from three companies with better than average safety records. Analysis of data from the 54 measurable characteristics revealed that 19 could be used to describe a final set of five latent variables. This gave them the result and conclusion that these five latent variables can be considered characteristics of corporate safety culture and may be used as indicators of safety performance as measured through EMR. Based on the findings from the limited sample of three companies, author proposes a list of practices that companies may consider to improve corporate safety culture and safety performance.

Sherif. Mohamed [3] discusses empirical research aimed at examining the relationship between the safety climate and safe work behavior in construction site environments. A research model was developed and tested using a survey, which contained multiple measurement items relating to each of the constructs in the model. A questionnaire survey was used in order to facilitate the collection of information from construction sites. This resulted and concluded that the empirical results indicate a significant relationship positive association between the safety climate and safe work behavior. Positive safety climates seem to result from management's showing a committed and non punitive approach to safety, and promoting a more open, free-flowing exchange about safety related issues. Contrary to the expectation, this study indicated that work pressure has no significant direct relationship with the safety climate. The results corroborate the importance of the role of management commitment, communication, workers' involvement, attitudes, competence, as well as supportive and supervisory environments, in achieving a positive safety climate.

Rafiq. M. Choudhry; Dongping .Fang; Helen. Lingard[4] determine safety climate that would enhance safety culture and positively impact perceived safety performance on construction projects. A safety climate questionnaire survey was conducted on the construction sites of a leading construction company and its subcontractors. Approximately, 1,500 hard copy questionnaires were distributed and the response rate was excellent, resulting in 1,120 valid questionnaires being collected from 22 construction projects. From FA, two principal components were established, management commitment, employee involvement and inappropriate safety procedure and work practices. These factors have been regressed with the perceived safety performance scores to establish the causal relationship between safety climate and perceived safety performance. This finally made them to come to the conclusion that the two-factor solution explained a total of 43.9% of the variance, with factor 1 contributing 27.62% and factor 2 contributing 16.28%. During the multiple regression analysis, the two underlying factors were used as independent variables in evaluating the relationship with perceived safety performance. The study concluded that management may be warned of potential safety system failures by measuring safety climate and can assess how safety is functioning in construction site environments. The results suggest that safety climate can be used as an effective measure of assessing and improving site safety for projects under construction.

Aviad.Shapira; F.Asce, BenyLyachin[5] presents the results of a study that identified the major factors affecting safety in tower-crane environments and evaluated the degree to which each factor influences ongoing safety on site. This study presented a list of 21 factors with an ongoing presence that affects safety in tower-crane environments. The list was generated and consolidated based on the experience and expertise of 19 senior safety managers and equipment managers from the top ten construction companies, which among them own and employ some 300 tower cranes. With a view to quantifying risk factors, the experts also assessed the influence of each of the factors, thus making it possible to distinguish between factors that exert a strong influence and those that exert a moderate influence on site safety. Overall we get to study in this paper that ,with the limited resources available for safety improvement and accident prevention, greater attention must be paid by all parties involved e.g. construction firms, regulatory and enforcement authorities to those factors evaluated as highly affecting site safety due to tower-crane work. The study reported in this paper constitutes the first phase of a broader research plan that aims to develop quantitative indices that objectively and realistically reflect safety levels on construction sites due to the operation of tower cranes. Alexander .

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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Laufer; M. Asce; William B. Ledbetter;F. Asce [6]deals with the effectiveness of the various methods and the extent of their use at construction sites are examined. The study is primarily based on a sampling of medium and large construction sites. Attributes that are investigated include efficiency, reliability, and validity and diagnostic capacity of the measure in order to identify the cause for success or failure, respectively, of the safety program at a site. Data were collected through the medium of a questionnaire mailed to safety directors of the 400 largest U.S. contractors listed in the Engineering News Record. The conclusion is drawn that for the successful safety performance at construction sites, the simultaneous employment of a number of measuring methods is required. The results of this study clearly indicate that the most effective and at the same time the most widely used employed measurement methods were lost-day cases, doctor's cases, and cost of accident. No-injury cases were least effective and least in use. Process methods were found to be effective as far as their validity and diagnostic capacity extends, though their efficiency and reliability are low.

Suchismita.bhattacharjee; somik.Ghosh [7] attempt to identify the limitation of the prevailing safety approaches which reviewed the major approaches that have been implemented to improve occupational safety in construction industry. Evaluating nine major approaches in terms of techniques and effectiveness which includes personnel selection, technological intervention, behavior modification, poster campaign, quality circle, exercise and stress management, near-miss accident reporting, safety climate, and zero injury technique, it was found that all the approaches transfer the burden of responsibility on the contractors. While the role of the contractors in the occupational safety and health risks of the workers is undeniable, yet the lack of improvement in the safety performance of construction industry in comparison to others have urged the practitioners and researchers to look for novel concepts. PtD (Prevention through Design) is such a concept, which if embraced by the construction industry and utilized properly can minimize occupational safety and health risks. This finally made them to come to the conclusion that the utilization of this concept calls for architects and engineers to participate in enhancing construction site safety. PtD concept utilizes the fact that architects and engineers are in a position to make decisions about construction safety and reduce or eliminate certain identifiable risks before those risks reach the construction site.

Qian.Chen; A.M.Asce, Ruoyu.Jin[8] presents a case study of an on-site safety management program launched by a general contractor. The initial research findings based on data analysis of incident rates (reactive measurement) and safety violations (proactive measurement) were presented to quantitatively assess the effectiveness of the program. By comparing various before and after incident rates and IRs during the 17-month study period, this research found that the Safety4Site program was effective in preventing and reducing jobsite accidents/incidents in the GC's organization. In contrast, Subs' incident rates were not significantly affected by the program. This gave them the conclusion that the top four most violated items, accounting for 82% of total violations, were all related to fall hazards. Besides safety, who reported around 33% of violations, project management personnel reported another 63%. This indicated strong participation and accountability among middle management personnel. Data showed that the program had a higher positive effect on the GC (with decreased SVRs) than on Subs in reducing unsafe behaviors. A co- relational study found no any linear relationships between IRs and SVRs for the GC, two uncorrelated measurements of safety performance. A lower incident rate does not necessarily mean a safer jobsite because some unsafe behaviors may not become an accident. Which overall gives the result that both reactive and proactive measure should be used to evaluate jobsite safety performance and the effectiveness of a safety program.

Xinyu .Huang; Jimmie.Hinze[9] presents the results of a study on the owner's role in construction safety which was demonstrated through the project characteristics, the selection of safe contractors, the inclusion of safety requirements in the contract, and the owner's active participation in safety during project execution. Through analysis of the project interview data, it can be concluded that owners can positively influence project safety performances. Several practices of owners that were associated with better safety performances were identified. This study also found that petrochemical owners are among the most proactive owners in construction safety. They help to explain why the safety performances of petrochemical projects are better than other types of projects. This finally made them to come to the conclusion that by identifying practices of owners that are associated with good project safety performances, guidance is provided on how owners directly impact safety performance.

According to P.S. Sathish.Kumar; M. Logesh. Kumar[10] presents the results of a questionnaire survey, which was distributed among the construction sites and formal interviews with the key personnel at sites. The criterions considered for survey are safety programs and policy, safety program implementation, use of personal protective equipment, hazards and their protection, housekeeping, emergency compliance. This study revealed that Safety is a management

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

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initiative, which was found completely lacking on all most all the sites surveyed. Generally, all aspects of safety are neglected at construction sites. The results of this study clearly indicate that the most critical factors like safety policy, awareness among the workers and falling hazards are neglected. Even though personal protective equipment are being used at many sites, hand glove are widely used mainly for concreting operations. Also in some sites helmets were found to be used for carrying water and storing oil which is used for applying to the formwork. This gave them the conclusion that Barricading, handrails and signage are not provided, to safe guard the person from falling, in most of the sites. Proper stacking of material is not done. Majority of the sites do not have their access ways clear from obstruction. In most of the sites trained operators were not used for operating the machineries and there is lack of manual of maintenance at the site. Site engineer/ Site-in-charge did not know the capacities of the equipment's present at the site. Traffic signage and flagging was completely absent in all most all of the sites. There was complete ignorance about the laws and rights of labourers. Also there were no labour unions to fight for the labour rights. No contractor has been given notice regarding unsafe working conditions by any government department,

III. MODELING AND ANALYSIS

Step 1: (Data collection).
Step 2: (Training and testing data separation) For a moderately sized data set, 80% of the data are randomly selected for training, 10% for testing, and 10% secondary testing.
Step 3: (Network architecture) Important considerations are the exact number of perception's and the number of layers.
Step 4: (Parameter tuning and weight initialization)
Step 5: (Data transformation) Transforms the application data into the type and format required by the ANN.
Step 6: (Training).
Step 7: (Testing).
The testing examines the performance of the network using the derived weights by measuring the ability of the network to classify the testing data correctly.
Black-box testing (comparing test results to historical results) is the primary approach for verifying that inputs produce the appropriate outputs.
Step 8: (Implementation) Now a stable set of weights are obtained.

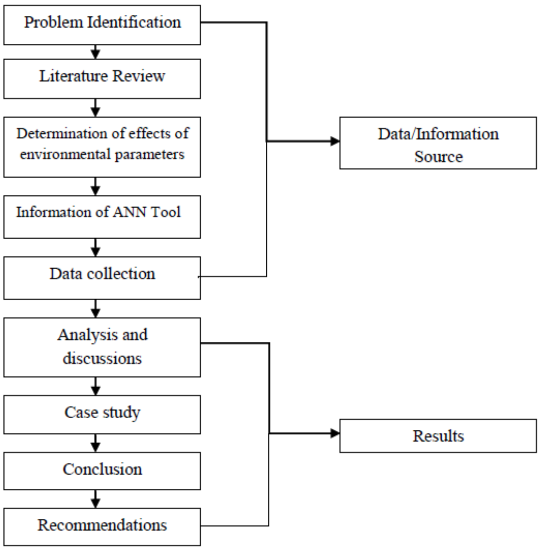

Figure 1: Proposed system flowchart

An Artificial Neural Network (ANN) is an information-processing system that has been established as overviews of calculated representations created on hominoid neural biology. An ANN is serene of nodes related by directed links. Each link has a numeric weight as shown in Figure 2. ANNs have many advantages over traditional methods for modeling due to their distinct features. ANNs determine complicated relationship among a set of data and where the relationship between data is highly unknown. ANNs are data obsessed and self-adaptive devices because they can seizure subtle purposeful contacts among the figures uniform if the causal affiliation is hard and complex. They can

ISSN: 2350-0328
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automatically adjust their weights to optimize their behavior unlike mathematical and statistical models. ANNs are bright to detain complex nonlinear relationship with better accuracy.

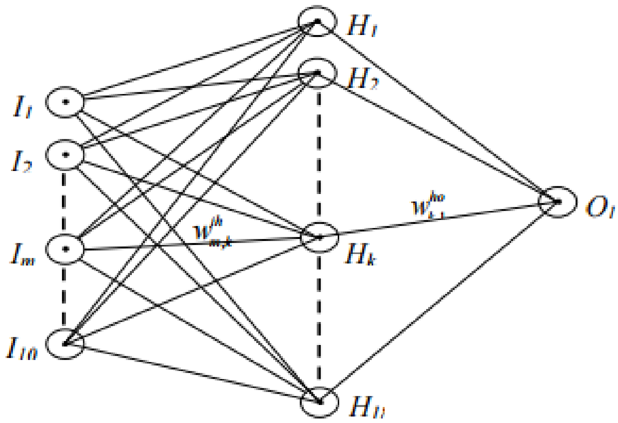

Figure 2.Configuration of the developed neural network (12-12-1)

ANN based models generate better prediction outcome than those obtained from regression models. Some existing surveys have been defined, it is not necessary that data should follow a specific statistical distribution. Also, there is no requirement as such to training the inter relationship among inputs and outputs before developing an ANN based model. ANNs consume been castoff for cataloguing, collecting, vector quantification, control, decoration suggestion, estimate, occupation calculation, and optimization. Due to its useful features, ANN is a popular research tool even in construction management. The connection among safety environment and their constructs is nonlinear and complex. Nevertheless, ANNs have the capability to expect shelter environment of a construction project.

For this survey we have collected around 12 parameters data from each site. These are below

(1) Commitment
(2) Communication
(3) Safety rules and procedures
(4) Supportive environment
(5) Supervisory environment
(6) Workers' involvement
(7) Personal appreciation of risk
(8) Appraisal of physical work environment and work hazards
(9) Work pressure
(10) Competence
(11) Working hours
(12) Life covers

Processing with Weka Toolbox

ISSN: 2350-0328
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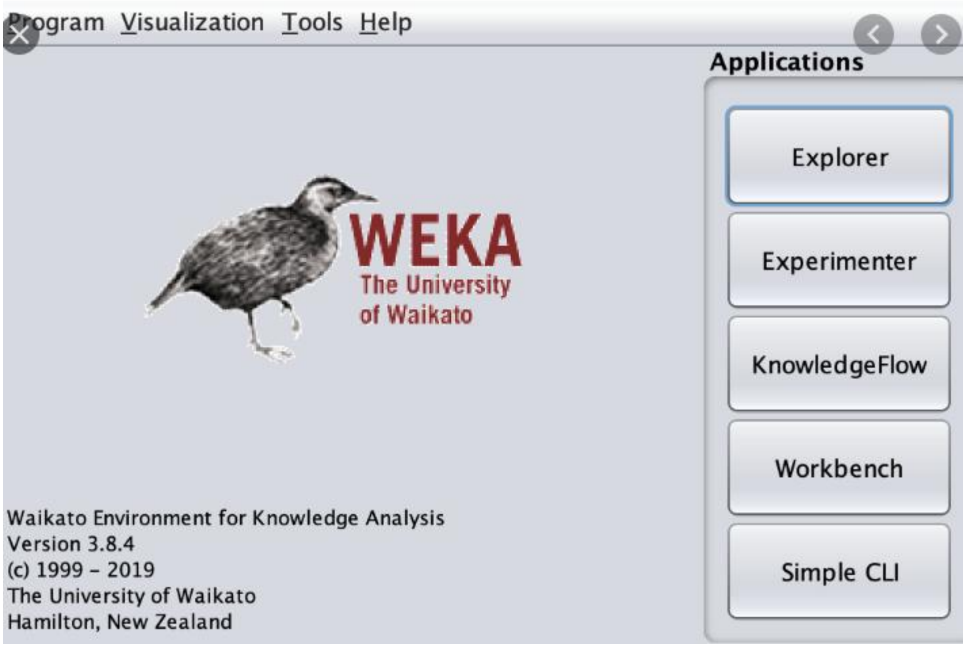

Figure 3: Weka toolbox simulation creation page

```
@relation Commitment real
@attribute Communication real
@attribute Safety-rules-and-procedures real
@attribute Supportive-environment real
@attribute Supervisory-environment real
@attribute Workers-involvement real
@attribute Personal-appreciation-of-risk real
@attribute Appraisal-physical-work-environmentworkhazards real
@attribute Work-pressure real
@attribute Competence real
@attribute Working Hours real
@attribute Life Cover real

data
4,4,3,5,3,2,4,4,3,3,4
1,2,3,2,1,4,5,2,3,1,3
4,2,1,4,3,3,2,1,4,2,5
3,3,3,2,5,4,2,1,4,2,2
4,4,3,5,3,2,4,4,3,3,2
1,2,3,2,1,4,5,2,3,1,1
4,2,1,4,3,3,2,1,4,2,1
3,3,3,2,5,4,2,1,4,2,2
4,4,3,5,3,2,4,4,3,3,3
1,2,3,2,1,4,5,2,3,1,3
4,2,1,4,3,3,2,1,4,2,2
3,3,3,2,5,4,2,1,4,2,2
4,4,3,5,3,2,4,4,3,3,3
1,2,3,2,1,4,5,2,3,1,4
4,2,1,4,3,3,2,1,4,2,3
3,3,3,2,5,4,2,1,4,2,2
4,4,3,5,3,2,4,4,3,3,1
```

Figure 4 : input data file of survey

In this survey first we collect around 60 site survey from different zones, each survey having a start rating for each parameter. The all parameter file convert into .arff and .csv file, after that for first experiment done with and weka 13 toolbox, we given different hidden layers with 12 input neurons. The table 3.4 shows the overall result of proposed survey

.

IV. RESULTS AND DISCUSSION

For the validation of proposed study, we evaluate our results with real time construction projects. The Figure 4.4 show current scenarios for safe environment in real time construction. We have validate the results with Vaishnavi Developers, the tables 4.3.13 is the rank result with each parameter.

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Table 1: Comparison of Actual and Predicted Performance of Safe Climate

Input	Normalized Weight	Rank
Commitment	0.45	9
Communication	0.55	6
Safety rules and procedures	0.37	12
Supportive environment	0.50	8
Supervisory environment	0.77	1
Workers' involvement	0.73	2
Personal appreciation of risk	0.56	5
Appraisal of physical work environment and work hazards	0.72	3
Work pressure	0.66	4
Competence	0.54	7
working hours	0.37	11
Life Cover	0.44	10

The typical utilizes protection climate concepts (determinants) as ideas and safe work performance as an productivity. A three-layer feed-forward back-propagation neural link (12-12-1) was appropriate in building this model which has been trained, validated, and tested with sufficient data sets. The classical foresees the safe exertion behavior of workers reasonably well. In calculation, a sympathy scrutiny was carried out to homework the effect of each construct on the safe work comportment of employees. As a effect, security climate paradigms like controlling environment, work pressure, employees' involvement, personal appreciation of risk, and supportive environment were significantly linked with the safe work conduct of employees. This classical has great latent in aiding independents and customers in promoting safe work performance and the efficient management of the protection of employees in construction projects.

Figure 4.3 shows an artificial neural network with 12 input neurons (determinants), one output neuron (safety climate), and in- between 12 hidden neurons and 1 output neurons. The interconnect weights of input-hidden layers and hidden-output layers as well as biases are generated and presented. The closed-form method can be presented which predicts the safety environment. It requires the values of weights and biases. Table 4.1 shows the evaluation of the actual and predicted performance for the model. The absolute percentage deviation (APD) remains in the permitted range, and so the model expects practically well. Thus, security officer, project manager, and project executive can use it to evaluate and expect safety environment on construction spots and thereby managing safety effectively.

Table 2 : Comparison of Actual and Predicted Performance of Safe Climate

Sample No.	Actual safety climate	Predicted safety climate	APD (%)
1	0.59	0.68	13.24
2	0.72	0.75	4.00
3	0.66	0.69	4.35
4	0.65	0.68	4.41
5	0.80	0.75	-6.67
6	0.70	0.69	-1.45
7	0.75	0.75	0.69
8	0.67	0.71	5.63
9	0.78	0.72	-8.33
10	0.70	0.71	1.41
11	0.71	0.72	0.74
12	0.70	0.68	-2.94

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Table 3: Safety Parameters achieved from proposed study

Input	Rank
Supervisory environment	1
Workers' involvement	2
Appraisal of physical work environment and work hazards	3
Work pressure	4
Personal appreciation of risk	5
Communication	6
Competence	7
Supportive environment	8
Commitment	9
Life Cover	10
working hours	11
Safety rules and procedures	12

Table 4:Safety Parameters followed Vaishnavi developers

Input	Rank
Supervisory environment	1
Workers' involvement	2
Work pressure	3
Appraisal of physical work environment and work hazards	4
Personal appreciation of risk	5
Communication	6
Competence	7
Supportive environment	8
Commitment	9
Safety rules and procedures	10
working hours	11
Life Cover	12

The Table 4.5.1 and 4.5.2 show the comparison between two different systems, Table 4.5.1 is our achieved ranked parameters from proposed study, and 4.5.2 is the Safety Parameters followed Vaishnavi developers. The proposed study is around 85% truly recommend with real time environment. So, the proposed results can be 100% validate for safety environment parameter in construction projects.

V. CONCLUSION

This research developed a robust model based on ANN to foresee and gauge the safety work on creation projects considering ten constructs of safety climate. By making use of the model, this research found that promise, managerial environment, people thankfulness of risk and competence had significant roles on safety climate. Contrary to the expectations, this study found that safety rules and procedures, appraisal of physical work and work hazard, and work pressure had negative influence on safety climate. The rest of constructs: communication, supportive environment and workers' involvement were found unbiased in development of security climate. Therefore, the findings from this research desire project executives to focus on positive constructs of safety climate instead of all ten constructs. These positive constructs are more suitable to learning the protection climate in Indian construction industry. The main implication of this study is that practitioners can evaluate the protection environment of the particular project and compare with another projects or organizations easily. Researchers can use this model to quantify protection environment and study its impact on other factors like safety budget, safety outcomes etc.
The findings indicated that the relationship between perceived safety performance and inappropriate safety procedure and work practices was inversely correlated. The results suggest that safety climate can be used as an effective measure of assessing and improving site safety for projects under construction. The findings of this study and the methodology might be useful for research at other construction sites in other regions and countries. This work provides useful

information for project managers and safety practitioners who desire to improve safety climate and safety performance on construction sites. The above survey show the how we can maintain the safe work into the construction environment.

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