

# Evaluation and Prediction of Health and Safety Culture in a Construction Industry Using Artificial Neural Network

Athira S<sup>1</sup>, Veena R<sup>2</sup>, Rijul M<sup>3</sup>, Danish T<sup>4</sup>, Suja mathew<sup>5</sup>, Henna<sup>6</sup>

U.G. Student, Department of Safety Engineering, Eranad Knowledge City Technical campus,

Manjeri, Malappuram, Kerala, India<sup>1</sup> Orcid Id: 0009-0005-5170-8652

Assistant Professor, Department of Safety Engineering, Eranad Knowledge City Technical campus,

Manjeri, Kerala, India<sup>2</sup> Orcid Id: 0000-0001-5238-4972

Assistant Professor, Department of Safety Engineering, Eranad Knowledge City Technical campus,

Manjeri, Kerala, India<sup>3</sup> Orcid Id:

Assistant Professor, Department of Safety Engineering, Eranad Knowledge City Technical campus,

Manjeri, Kerala, India<sup>4</sup> Orcid Id:0000-0003-2104-2616

Assistant Professor, Department of Safety Engineering, Eranad Knowledge City Technical campus,

Manjeri, Kerala, India<sup>5</sup> Orcid Id: 0009-0003-6470-0006

Assistant Professor, Department of Safety Engineering, Eranad Knowledge City Technical campus,

Manjeri, Kerala, India<sup>6</sup> Orcid Id:0009-0001-0948-1424

**ABSTRACT:** Safety culture is one indicator of construction site safety performance. It is a dynamic “snapshot” of each organization's safety culture. It reflects employees' perceptions, attitudes and behaviours regarding the current safety situation at construction sites. Key components of safety culture are identified through a literature review. The structure is believed to influence worker behaviour within a project. The purpose of this research is to develop a model to predict safety culture in construction projects using MATLAB artificial neural networks (ANNs). The construct is used as input and safe climates are used as output for the ANN algorithm. In this study, 100 responses were collected from each person through questionnaire surveys at selected sites. Management, communication, workload, level of education, monitored environment, and personal protective equipment can be suggested as effective and positive components of a safety culture based on findings. Finally, some effective measures have been suggested to improve the health and safety culture in the construction industry.

**KEYWORDS:** Health and safety culture, Artificial neural network, Construction industry.

## I. INTRODUCTION

Development in labor security could be a major challenge for areas of development around the world. Keeping up a positive security culture is fundamental for any organization to avoid mishaps on development sites. An organization's well-being and security culture could be an item of the person and can bunch values, demeanors, recognition, competencies, and behavioral styles that drive the commitment, design, and ability of the organization's wellness and safety management. A positive security culture can progress security execution to an extent because it straightforwardly relates to security execution [1].

Security culture expectation makes a difference in recognizing shortcomings in security culture. So remedial activity can be taken for some time. Recently an occurrence happened. This permits successful dealing with security issues and empowers nonstop advancement procedures to be created at the development location. Mishaps are frequently startling, impromptu occasions or circumstances that are not aimed at or essential. It can be characterized as an undesirable or terrible occasion that happens inadvertently and ordinarily comes about in hurt, harm, harm, misfortune, or mischance.

A solid, positive security culture avoids mishaps. Make strides in efficiency, ethical and legitimate interface. Subsequently, the reason for this inquiry is to create a show for foreseeing security culture at development locales based on an Artificial neural network (ANN) show.

## II. RELATED WORK

The basic components influencing assurance by and large execution in developing development. Moreover, inspected is the current level of security mindfulness in development, to decide the critical components influencing security execution and to assess the potential measures for progressing the development workers' security mindfulness [2]. The pursuit of security subculture and assurance climate. They set up that appraisal of security climate can foresee the level of the security culture of development organizations. They defined speculation and concluded that security climate affects the mental angle, behavioral angle, and natural or situational perspective of security culture. Still, no critical exertion has been made to anticipate the security climate on development ventures so distant, considering its determinants.[3] There's no agreement around the figure structure of the security climate [4] carried out basic condition modeling to affirm that the ten constituents of security climate are consistent with observational proof. The ten security climate builds are commitment (recognitions of management's unmistakable commitment to wellbeing and security issues) (I1), communication (the nature and proficiency of wellbeing and security communication inside the organization) (I2), security rules and strategies (sees on the adequacy and need of rules and strategies) (I3), steady environment (the nature of social environment at work) (I4), supervisory environment (solid relationship between administrator and laborers (I5), worker's involvement (the degree to which security could be a centre for everybody and all are included) (I6), faculty appreciation of chance (how people see the chance related with work) (I7), evaluation of physical work environment and work dangers (recognitions of the nature of the physical environment) (I8), work weight (specialists feel beneath weight to total work as per time arrange) (I9), and competence (alludes to the common level of worker's capability, abilities, information, involvement, and preparing) (I10).

Additionally, other related ponders [5,6] moreover displayed observational proof that comparable ten components affect profoundly security climate in development location situations. These determinants influence the level of secure work behavior and cover wide regions in terms of organizational setting, social environment, person appreciation, and work environment. These determinants show the genuine picture of security culture, and they have the potential to infer security culture.

The article by Unnikrishnan and Madhu (2019) reports on a comparative ponder of the impacts of meteorological and poison parameters on manufactured neural arrange (ANN) modeling for the expectation of sulfur dioxide (SO<sub>2</sub>) concentrations. The creators collected information on different meteorological and poison parameters from a mechanical zone in India and utilized this information to prepare and test ANN models for foreseeing SO<sub>2</sub> concentrations. They found that the consideration of meteorological parameters essentially progressed the exactness of the ANN models in which the best-performing show included both meteorological and poison parameters. The creators recommend that their discoveries may well be valuable for making strides discuss quality checking and determining in mechanical areas.[7]

## III. METHODOLOGY

Evaluation and forecast of well-being and security culture carried by these steps incorporate, collecting information through a survey study. The essential point of the survey was to gather significant information for the development of an expectation demonstration. The questionnaire consisting three parts. The primary portion of the survey was planned to procure individual data from a respondent. The 20 security climate builds were recorded within the moment part of the survey. For assessing security culture, ten articulations are given within the third portion of the survey. Determination of inputs and yield is vital to the advancement of an ANN-based forecast show [8,9]. In this consideration, for the demonstrated improvement, twenty constructs are taken as inputs and security climate is taken as a yield. The questions within the survey evaluated the centrality of the 100 to measure the phonetic terms.3) By doling out a rise to weight to each property, a dimensionless amount, develop list CI, was computed to speak to the esteem of each security culture build. To measure the phonetic terms required for the think about emphatically oppose this idea, oppose this idea, not one or the other concur nor oppose this idea, concur, and emphatically concur were relegated values -1.00, -0.50, 0, 0.50, and 1.00, separately, against each quality to calculate the build files. The CI compares the characteristics of the pertinent build of security culture.

The run of CI is between  $-1$  and  $+1.4$ . Each of the 100 crude information was randomized utilizing ANN was categorizing in preparing, approving, and testing information sets to extend the precision of the show. Out of add up to 100 tests utilized in the improvement of the show in which 75 (75%), 10 (10%), and 15 (15%) tests were utilized for preparing, approving, and testing the organized, individually. [10,11]

## STUDY AREA AND SOFTWARE USED

The area selected for the study is IMA Doctors Enclave Manjeri, Malappuram which is located in the south Indian state of Kerala. IMA Doctors Enclave is a residential development in Manjeri. The project is built by IMA Welfare and Research Society. They provide skilfully designed flats with all necessities.

MATLAB R2021a (The MathWorks Inc. USA) was used to develop safety culture and prediction models. A Neural Network Toolbox is used for the development of ANN models.

## IV. EXPERIMENTAL RESULTS

The training of the networks is done using the neural network toolbox for the model. After training the network, the neural network was obtained, which is shown in Fig.1.

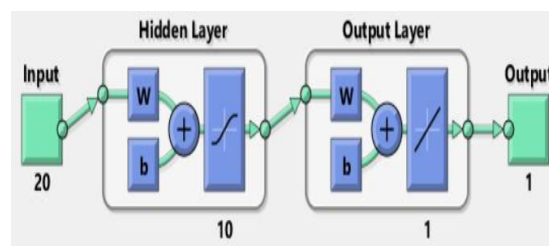


Fig.1 Neural network diagram of ANN model

The structure of the ANN model consists of 20 input parameters and one output. The model was trained using a varying number of hidden neurons from 1 to 41 ( $2 \times 20 + 1 = 41$ ), and also varying the delays by the trial-and-error method. Comparing the results for 1 to 41 neurons, it was concluded that the best performance of the model was noted with 10 hidden neurons, which resulted in a correlation coefficient (R) value of 0.924074 (very close to 1).

Fig.2 shows the regression analysis plots of the safety culture networks. In the regression plot, the solid line indicates the perfect fit, which shows the perfect correlation between the predicted and target values. The dashed line in the regression plot represents the best fit produced by the algorithm.

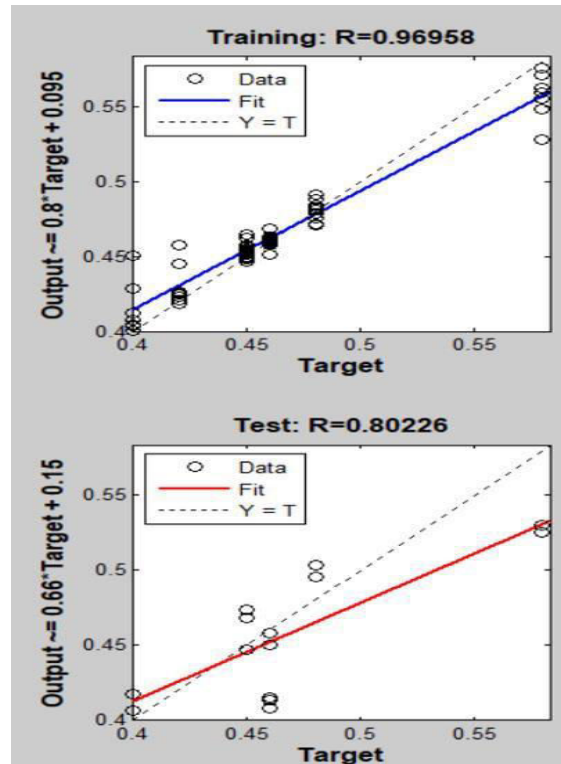


Fig.2 Regression Plot of Safety Culture

Comparing the results for 1 to 41 neurons, it was concluded that the best performance of the model was noted with 10 hidden neurons, which resulted in a correlation coefficient (R) value of 0.924 (very close to 1), shown in Figure and so the model predicts reasonably well. That means the construction site has a positive health and safety culture. This indicates that for the next 3 years also, the company has a positive culture.

There were a few factors which have to be improved. Hence, some potential measures were suggested to improve the health and safety culture. [12,13]

1. Effective communication
2. Install a fall protection system
3. Regular safety inspection
4. Safety reward scheme
5. Emergency response preparation
6. PPE Programme
7. Reorganization of safety training
8. Selection of management
9. Prevention through Design (PtD)
10. Safety promotion

## V. CONCLUSIONS

In the present study, a model is developed to predict the safety culture of a construction project using the artificial neural network (ANN) in MATLAB. The constructs are used as inputs and the safe climate is used as output for the ANN algorithm. The ANN model is evaluated by using the Root Mean Squared Error (RMSE) and Coefficient of determination ( $R^2$ ) values.

The  $R^2$  value and RMSE value calculated were 0.924 (very close to 1) and 0.0127 (very close to 0) which shows the model results in good performance. That means the construction site has a positive health and safety culture. This

indicates that for the next 3 years also, the company has a positive culture. It is possible that the safety climate constructs, despite having a positive causal relationship to the network output, are simultaneously related to unidentified confound factors that are negatively related to the network output.

Some areas needed improvement. Some potential measures have therefore been proposed to improve the health and safety culture [14]. Like effective communication, installing a fall protection system, regular safety inspection, safety reward scheme, emergency response preparation, PPE program, reorganization of safety training, selection of management, prevention through design (ptd), and safety promotion.[15]

This research has a few limitations. Self-report measures may exaggerate the safety climate of a project, so it is a clear limitation of this study. The responses collected were broadly from individuals working in middle management for this study, but responses from persons working in top management, contractors, and their workers can be accommodated to get a better picture of the safety culture. These limitations may be addressed in a future study.

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