Measurement and Modeling of Job Stress of Electric Overhead Traveling Crane Operators

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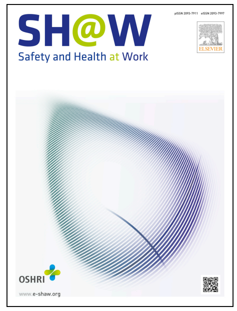

Measurement and modeling of job stress of EOT crane operators

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Abstract

In this study, the measurement of job stress of EOT crane operators and quantification of the effects of operator and workplace characteristics on job stress are done. Job stress is measured on five subscales, namely employee empowerment, role overload, role ambiguity, rule violation and job hazard. Operators' characteristics considered are age, experience, body weight and body height whereas the workplace characteristics considered are exposure hours, cabin type, cabin feature, and crane height. The proposed methodology includes administration of questionnaire survey to 76 EOT crane operators followed by analysis using ANOVA and classification and regression tree (CART). The key findings are: (i) the five subscales can be used to measure job stress, (ii) employee empowerment is the most significant factor followed by the role overload, (iii) workplace characteristics contribute more towards job stress than operator's characteristics, and (iv) of the workplace characteristics, crane height is the major contributor. The issues related to crane height and cabin feature can be fixed by providing engineering or foolproof solutions than relying on interventions related to the demographic factors.

Keywords: EOT crane operations, job stress modelling, CART.

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1. Introduction

Electric Overhead Traveling (EOT) Cranes are major material handling equipment in any heavy engineering industry. EOT crane operators operate cranes from the cabins and are responsible for unloading, transporting and loading of various materials. Heavy loads, standardized layout for controls, sequential operations, and lack of training [1] are some of the organizational issues that can make crane operations a difficult and boring task. A study conducted by Eatough et al. demonstrated that high level of role conflict, low job control, and low safety are associated with increased employee stress [2]. Stress, in turn, is related to higher levels of musculoskeletal disorder (MSD) symptoms of the wrist/hand, shoulders, and lower back. Therefore the operators' stress is influenced by work, workplace, organization and individual factors.

The individual factors considered are age, education, experience, job position while the organizational factors considered are workload, role overload, role conflict, role ambiguity, poor career development and poor interpersonal relations [2-5]. Work related factors causing job stress are demand, control, support, relationship, role and management of change [6-10].

There is a relationship between major job related stresses (like, workload, lack of control, and interpersonal conflict) and a set of various performance indices [11-13]. Job stress has negative effect on health and well-being of the workers in an organization [14]. In a study, Rundmo found out some differences in perception of risk amongst employees engaged in working in various offshore installation platforms and noted that bad working conditions could lead to higher job stress resulting in work injury [12]. Staff burnout, a common reaction to job stress, could hamper the human performance in service, but that could be alleviated by recommended strategies as explained by Cherniss [15]. Some studies were also carried out on the job strain and depressive symptoms in men and women [16]. Wong et al. aimed to examine the role of work/non-work conflict between firemen's job stress and job demand, job support and family support by structural equation modeling (SEM) through questionnaire survey for data collection from 422 firemen [17]. Through the result of their analysis by SEM, they could address Work/leisure conflict (WLC) and work/ family conflict (WFC) mediate partially the relationship between job demand and job control, job support and job stress. The relationship between family support and job stress is fully mediated by WLC and WFC [17]. Psychological job characteristics accountable for psychological stress subject to organizational change are also the key factors for increasing the mental stress [18]. Through the literature survey, it has been found that the structural changes within company or any organization can create a set of work related stressors like, increased job demands (work through long hours, more work pressure, and others), less control level, role ambiguity, and more importantly, changes in opportunities for social support from supervisors (like, less number of managers, unavailability of proper guidance, and recognition, and so on) [18]. Mental stress being dependent on these factors could be augmented along with other consequential effects like, less commitment level, less job satisfaction, and others [19-22]. Many researchers attempted to validate the previous findings on the relation between workers' mental health and job stress level by removing the impacts of unobserved time-invariant confounders [23]. Changing structure of work in our society and many organizational factors are responsible for decrease or increase of the job stress level [24]. Sometimes, nature of the work, which is entrusted upon workers, could also provoke the level of job stress. Therefore, allocation of work with clear and distinct roles and responsibilities is a necessary tool. Coping with job stress is a key concept in understanding people's adaptation to their work roles. To reduce the job stress, a psychological process dealing with various kinds of job stressors is called 'coping' as expounded by Schaufeli [25]. From this study, it is evident that coping with job stress could handle the stressors encountered during work time. This study illustrated the concept of dynamic interplay of the employee and job environment or work setting considered as stressful in terms of threat, or harm [25]. Another research study by Ouyang et al. tried to highlight the job satisfaction. It discussed about individual difference in emotional intelligence that could influence job satisfaction [26]. Some studies also illustrated the concept - 'burnout' caused by excessive and prolonged job stress [27]. Some other criteria, like macro-economy have influence on job satisfaction, employee engagement, and level of satisfaction [28]. There might be correlation with depression and work absence indicators that could help the researchers and clinicians adequately assess the job strain of workers in workplace [29]. Belias et al. investigated to measure the role conflict, level of job satisfaction, and autonomy of employees in Greek banking organisation [30]. Their findings confirmed that role conflict was negatively correlated with job satisfaction.

Over the years, researchers have been attempting to model job stress under varied conditions of work systems [6, 8, 31-33]. Four important models developed between 1980-2000 are detailed here, which would be helpful for developing the model for the present scenario. Cooper's model [32] considers number of stressors, viz. job demand, role in the organisation, relationships at work, career development, organisation structure and development and home-work interface that act as a source of stress on an individual. The job stress model as proposed by Addley [8] is represented as human performance curve. It mentions about a threshold value of positive stress that is required for achieving good performance. However, increase in stress beyond the limit of positive stress threshold results into drop in the performance, exhaustion and eventually burnout or a nervous breakdown. Job stress model, proposed by Palmer [6] emphasises on the importance of culture and its components as stressors. He considers six potential factors namely demand, control, support, relationship, role, and change that are derived from organizational culture and shows that these are manifested into individual symptoms such as tension, high blood pressure and organizational symptoms such as absenteeism, reduced staff performance, and increased hostility. Srivastava and Singh [34] developed a questionnaire containing 46 questions to assess the job related stress and is being used in Indian subcontinent. Srivastava and Singh (1981) have given 12 sub-scales for job stress. They are role overload, role ambiguity, role conflict, unreasonable group and political pressure, under participation, responsibility for the persons, powerlessness, poor peer relations, intrinsic impoverishment, low status, strenuous working conditions, and unprofitability.

Job stress studies vary from study design, data collection, and analysis schemes used [3, 8, 35-37]. The primary means of data collection is questionnaire survey [3, 8, 34, 37]. Job stress is not limited to any particular industrial sector and accordingly many studies, models and methods have been developed to deal with this issue. The underlying common technique is the cross-sectional study of questionnaires for the workers concerned. It could be a one-time, two-time (baseline and 12-month follow-up) [38] or even three-time observations (baseline, 3-month and 12-month follow-up) [39].

1.1 Motivation

The key issues in the job stress study that are still to resolve are measurement through questionnaire survey and analysis of survey data. Measurement of the job stress is context and culture specific and analysis includes both quantifying job stress and modelling its relationships with contextual variables. For example, it is recommended to use Srivastava and Singh's [34] model for Indian employees for modelling job stress in comparison to models developed elsewhere (e.g. Palmer's model or Cooper model). It should also be noted here that the contextual variables changes over time and so to culture over long period of time, the concerned models must be modified to suit the present day requirements. Another important issue is the quantification of contextual variables and their effect on job stress. Lee and shin [40] has pointed out the problems in quantifying the influence of the contextual variables on the job stress, particularly due to large dimensions with complex relationships. Further, job stress questionnaire data analysis is still in its infancy state, primarily dominated by frequency analysis. Lee and Shin has proposed to use data mining tools coupled with advanced statistical modelling [40].

Data mining tools provide several advantages over traditional statistical techniques. Data mining techniques being nonparametric doesn't require the distributional assumptions. Further, ill condition and overlapping data set can be split effectively, e.g., using techniques like classification and regression tress (CART). The other advantage is that if data contain structural zeros (obvious zero count because of the design of the variable considered), statistical methods often give erroneous results but data mining technique like CART can overcome this problem. Owing to the above problems, the present study is important for the several reasons. First, it augments the analysis of job stress questionnaire survey data through advanced statistical models such as analysis of variance (ANOVA) and factor analysis. Second, it uses CART to model the relationship of contextual variables with job stress for EOT crane operators in an Indian steel plant. Finally, in this process the study not only modifies the job stress dimensions to measure the stress level of EOT crane operators in the plant studied, but it provides avenues for EOT crane work system design as well.

The rest of the paper is organized as follows. In **Section 2**, the proposed methods are discussed along with its application to EOT crane work systems. The key findings and their implication are also discussed in **Section 2**, followed by conclusions in **Section 3**.

2. Methods

2.1 Variables and instruments

Two types of variables are considered; the criterion and the predictor variables (refer to Figure 1). The criterion variables are the dimensions of job stress namely employee empowerment (EE), role overload (RO), role ambiguity (RA), rule violation (RV), and job hazards (JH). The predictor variables comprise the demographic factors namely age, experience, body weight and body height of the crane operators and the task and workplace factors are exposure hours, cabin type, cabin features, and crane height.

To measure job stress, Occupational Stress Index developed by Srivastava and Singh [34] has been used as this was developed for shop floor employees working in India. As Srivastava and Singh's questionnaire are developed long back in 1981, its relevance to present industrial situation is a bit questionable. Hence, a brain-storming study involving plant personnel, crane operators, expert managers, and occupational health and safety (OHS) doctors of the plant has been conducted to design the questionnaire suitable for the study. In addition, models of the job stress such as developed by Cooper [6, 8, 32] have been critically reviewed to formulate the proposed model. Five sub scales are proposed namely, employee empowerment (EE), rule violation (RV), role overload (RO), job hazards (JH), and role ambiguity (RA) (refer to Figure 1). Then, the original 46 questions of Srivastava and Singh [34] are judicially split across the five modified sub-scales (MSS). The allocation of the 46 questions into 5 MSS is shown in Appendix A**.**

2.2 Sample and data

A cross sectional study has been conducted involving 76 EOT crane operators, operating 33 cranes in the cold rolling mill (CRM) under flat product rolling of an integrated steel plant in India. A crane operator is engaged in moving heavy objects on ground by sitting in the crane cabin at a particular height (30, 40 or 60 feet).

The relevant data to capture demographic variables, working conditions, and job stress are collected using two sets of questionnaires: (a) questionnaire of occupational stress index (OSI), and (b) questionnaire developed in this study to capture the demographic as well as working conditions of the crane operators. Data collection has been done either at the beginning or at the end of the shift with the help of trained persons. The purpose of the study has been explained and confidentiality is ensured to all the crane operators before collecting their data for the study. Supervisors are not included in the study as the answers given by the operators may be biased in their presence but their prior consent is obtained. To reinforce the confidence of the crane operators, one occupational health and safety (OHS) doctor is included in conducting the questionnaire survey.

Initially, 46 questions have been considered and the 12 OSI sub-scales are determined as per the scheme provided by Srivastava and Singh [34]. Most of the sub scales suffer from negative Cronbach alpha, which necessitates relooking with the dimensions as well as the questions. Moreover, as the number of dimensions is large (12 in number), factor analysis of the original 46 questions based on the 76 respondents has been carried out. Both unrotated and rotated factor analyses are done but no clear-cut factor patterns are identified. This may be attributed to the small sample size compared to the number of questions. Increase in sample size was prohibitive from time, cost and conventional point of view as the work was done in industrial setting. This necessitates the use of the researchers' knowledge in predefining the factors (dimensions) with appropriate manifest variables. The validity of the modified dimensions with indicator questions is determined by computing Cronbach's alpha coefficient values for each of the dimensions, which are 0.65 for employee empowerment, 0.61 for role overload, 0.62 for role ambiguity, 0.62 for rule violation, and 1 for job hazard (Table 1). The Cronbach's alpha coefficients are above the acceptable level (> 0.60, Nunally [41]). These 37 questions are comparable with the job stress questionnaire with 30 questions developed by Addley and are found to be covering all the fields affecting the job stress [8].

2.3 Model and analysis

In this study, all the predictor variables are made categorical in nature. For example, age is measured in three categories namely, operators with ≤ 35 years of age, operator with age between 36-45 years (age is converted into nearest integer) and operators above 45 years of age. The criterion variable job stress and its sub-scales are used as continuous variable (using summated score) or categorical (based on quartile values). The job stress model answers the following two questions:

Question 1: Are there differences amongst the predictor categories of each of the variables in explaining job stress or its sub-scales?

Question 2: What is the relative degree of influence of each of the predictor variables in explaining job stress synergistically?

To answer the first question, ANOVA model is used. As there are eight predictor variables with 19 categories altogether, and because of practical limitations, ANOVA is conducted separately for each of the variables as all the variable categories collectively create combinations of zero frequency. These zero frequency cells (combinations) are known as structural zeros which distort the estimation process and is wiser to be avoided. For the same reason, no parametric statistical tools (e.g., logistic regression) are used to answer question 2; instead the classification and regression tree (CART), a non-parametric technique is used to answer it.

For ANOVA, the data structure is shown in Table 2. For example, the predictor variable age is grouped into L levels (i.e., Age1, Age2,...., AgeL) and n_l (l=1,2,.., L) observations on the predictor variable level l, are collected.

Now, with respect to Table 2, an observation y_{li} can be written as

$$y_{li} = \bar{y} + (\bar{y}_l - \bar{y}) + (y_{li} - \bar{y}_l)$$
$$= \bar{y} + \gamma_l + \epsilon_{li} \quad (4)$$

Where, γ_l is the main effect of the l-th level (category) of the predictor variable.

ANOVA tests the following hypothesis:

H_0: $\bar{y}_1 = \bar{y}_2 = \cdots \bar{y}_l = \cdots = \bar{y}_L$

H_1: $\bar{y}_l \neq \bar{y}_m$ for at least one pair of (l, m) combination

A test statistic F is used to test H_0 with a level of significance α which is set equal to 0.05 (i.e., α=0.05).

If H_0 is rejected, one can conclude that the criterion variable, job stress differs across the predictor variable categories.

To answer question 2, classification and regression tree (CART, [42]) is used. It provides a decision tree using binary recursive partitioning algorithm. The tree consists of three types of nodes namely, root node, internal nodes and leaf nodes. For example, if one wants to predict job stress as a categorical variable with three classes namely low, medium and high level of stress with the help of predictors such as age, experience, and other demographical variables and/or with workplace factors, the root node starts with the criterion variable (job stress in this case). The root node is then split into two children taking into consideration of one of the predictors (e.g., age). These two nodes can either be treated as internal or leaf nodes where the leaf node is the end node that can't be split further but the internal node is split further with the help of one of the predictors. In this manner, the recursive split continues.

CART involves three steps namely tree growing, stopping, and prediction. For growing, the steps involve: (i) find each predictor's best split, (ii) find each node's best split, and (iii) split a node using the best split. The best split is determined based on impurity criterion where impurity is a measure of lack of homogeneity of a node in separating the classes of the criterion variable. To measure impurity Gini index [43] as defined below is used.

$$Gini = 1 - \sum_{i=0}^{c-1} [\,p(i\,|\,t)]^2 \qquad (5)$$

Where, $p[i|t]$ denotes the fraction of records belonging to class i at a given node t and c is the number of classes. The best split is one which possesses the least impurity. Generally the splitting continues until the improvement in impurity due to additional splits is not significant.

To augment the accuracy of the CART model 10-fold cross validation is performed. In 10-fold cross validation, the whole data set is divided into 10 numbers of subsets. Each time a subset (sample) is dropped and the model is developed using rest of the data. The model is then used to predict the values of the drop out subset and misclassification rate is computed. Then the sum of errors over 10-fold cross validation is estimated. The process is repeated and finally, one selects the tree with the smallest estimated error rate.

It should be noted here that multiple linear regression (MLR) could be used to model the situation as the dependent variable (job stress) is continuous in nature. We have adopted CART for two reasons: (i) we have categorised the job stress variable into three groups, i.e., operators with 'low job stress', 'medium job stress', and 'high job stress'. It helps in decision making by classifying operators into three broad groups and taking actions for high stress group of operators. MLR is not applicable for categorical dependent variable. (ii) to avoid the problem of normality and homoskedasticity assumptions of MLR. CART, being a nonparametric approach is able to handle ill-conditioned data and nicely partitioned them across predictor groups. Another alternative could be logistic regression for categorical dependent variable but it also suffers from the parametric assumptions of the log-odds transformation.

3. Results and discussion

The results obtained from ANOVA model are shown in Tables 3-4.

From Tables 3 and 4, it is seen that majority of crane operators are in the age group of 35 – 45 years of age (69.70%) and > 65 kg of weight (55.26%). Almost 47% are having work experience of more than five years and 52.63% are more than 5 feet 6 inches tall. The majority of crane operators (77.6%) use type B crane cabin, while only 22.4% use type A crane cabin. 51.3% operators operate with movable crane cabin while 48.7% operate with a static cabin. 69.71%crane operators operate at a crane height of 30 feet and 77.6% are exposed to work for 36 hours per week.

On comparing total and sub-group stress scores with operators' demographics and workplace characteristics, ANOVA suggests that significant differences in stress scores prevail in the following areas:

- Between operators weight groups (≤ 65 Kg and > 65 Kg) for employee empowerment,
- Between type A and type B cabin type for role ambiguity,
- Between movable and static cranes for job hazard,
- Among different crane heights for total job stress, employee empowerment and role overload, and
- Among exposure periods for role ambiguity and job hazard.

While ANOVA has been used to find out the effect of individual predictors on job stress and its dimensions separately, CART is employed to determine the collective effect of the predictors on the overall job stress levels of the EOT crane operators. To develop the CART model, the overall job stress is divided into three categories as per the following rules.

Rule 1: If an operator's job stress score is less than or equal to the first quartile value, the operator is subjected to low level of job stress.

Rule 2: If an operator's job stress score lies within inter quartile range (IQR), the operator is subjected to medium level of job stress.

Rule 3: If an operator's job stress score is greater than or equal to third quartile value, the operator is subjected to high level of job stress.

The classification tree map structure is shown in Appendix B. Figure B1 (in Appendix B) represents the overall tree structure where the nodes are represented using numbers. Since the original tree structure is very large in size to be represented in a single page the original tree model has been shown in parts in subsequent figures. The classification tree for job stress of the crane operators are shown in parts starting from Figures B2-B5 (in Appendix B).

Since the data samples collected were only 76 in number bootstrapping was done before developing the CART model. The bootstrap sample size is 1000. 10 fold cross validation was done for increasing the classification accuracy. To determine the contribution of individual predictors on job stress, CART calculates importance score for each of the predictors. The important scores of the predictors are shown in Table 5. It can be noted that age, crane height, cabin feature, operator's weight, operator's experience exposure time and cabin type are important factors contributing to the development of job stress on the crane operators. The relative importance of these factors is also derived based on normalized importance which is computed as a ratio of individual importance to that of the maximum importance of the predictors (Table 5).

CART's predictive ability is measured using a classification Table (see Table 6). For the study, CART correctly classified 76.7% of the overall cases.

The study results show that crane operators differ in stress related to employee empowerment for demographic predictor age, body weight and workplace predictor crane height. An interesting proposition regarding body weight and employee empowerment related stress is that lower body weight operators suffer from higher stress level. This may be due to the fact that the less obese operators have higher agility which makes them more active and hence look for higher empowerment. On the other hand, 30 feet high crane operators feel more stress related to employee empowerment which is of concern to the company studied. To improve it, major interventions may be needed. Management should look into the matter as to why 30 feet crane operators suffer from employee empowerment related stress. One of the reasons could be the nature of the job. As 30 feet crane operators carry out routine job of placement of materials at the ground level, they feel it monotonous.

Although rule violation is perceived to be an important component of job stress, none of the predictor variables shows significant relationship with it. This non-significant relationship may be interpreted that certain level of rule violation may be an acceptable fact across the EOT crane operators irrespective of their job profile. The rule violations can be reduced with engineering and administrative interventions. Operators working in 30 feet cabins are having more role-overload related job stress compared to operators working in 40 feet and 60 feet height cranes. In consideration of job hazard, static cabin operators perceive more job hazard as compared to movable cabin operators. One of the reasons could be that the movable crane operators has more flexibility to manoeuvre the machine and hence feel more secure to combat with any hazard related situations as compared to static cabin operators.

Finally, CART model indicates that operator's age, crane height, cabin feature, operator's weight, experience, exposure time and cabin type are important factors that collectively contribute to the development of job stress on the crane operators. Therefore management should consider collective effect of the predictors while designing interventions for reducing job stress.

It should be noted here that some of the predictors considered could be dependent on themselves or there could be confounding effects. The problem of confounding can be handled in CART with proper selection of the method of tree construction, amount of pruning and use of resampling methods such as bootstrapping. In addition, the problem of confounding is lessened as CART often implicitly deals with interactions and non-linearities.

4. Conclusions

In this study, a job stress model is developed for capturing significant predictors of job stress amongst EOT crane operators. The model considers 5 dimensions of job stress namely employee empowerment, role overload, role ambiguity, rule violation, and job hazard. The association between the predictors and the overall job stress and its dimensions is tested. Operator's age contributes the most followed by cabin height, cabin feature, operator's weight and operator experience. The assumption that the operators working at the higher crane height (e.g., 60 feet) will face more job stress as compared to the operators working at lower crane height (e.g., 30 feet) is not established in this study. A closer comparison into the facility provided for 60 feet versus 30 feet cranes reveals that operators at 60 feet height crane operate with movable cabin for less (24 hours/week) exposure hours as compared to the 30 feet height crane operators who work with static cabin for 48 hours of exposure. Hence, it is essential for the management to ensure that the operators are not exposed to all these situations simultaneously. They should provide interventions, at least, to one of the categories to reduce the job stress on the operators. Among the job stress dimensions, poor employee empowerment causes more stress and the operators' weight and crane height are the major differentiating predictors. Employee empowerment can be related to the control and support dimensions of job stress developed by health and safety executive, UK (HSE, 2001). The higher job stress related to poor employee empowerment can be tackled by allowing operators to control their pace of work, and providing support through developing skills and knowledge of the jobs assigned. The dimensions role overload, job hazard, and role ambiguity impose demand on the work. A certain level of demand is necessary but beyond a limit, it causes job stress [8]. Hence, improved employee empowerment can act as energizer resulting in higher work compatibility under high demand crane operations, which in turn reduce the job stress. This supports the concept of work compatibility developed by Genaidy et al. [44]. In summary, this study supports the existing concepts and models as discussed above and in addition, it brings out a few predictors of job stress for EOT crane operators such as crane height, cabin feature and crane type which are not reported in job stress literature.

Although the study contributes in developing and testing job stress model for EOT crane operators, it is subjected to certain limitations that should be kept in mind while implementing the research outcomes. First, the study incorporates empirical research methodology which is governed by the data collected from the field. Questionnaire-based perception data on job stress are used. Use of self-reported questionnaire data may provide biased information due to lack of understanding or perception. The results from the study as obtained are subjected to the adequacy of the questions used and reliability of the responses provided. As the study is carried out at a particular location, findings cannot be generalized to all parts of the working system. More replication studies are required. Finally, inclusion of a comparison group within similar work environment may give better idea of job stress of crane operators and its relation with work conditions.

It is believed that data mining is useful and is shown that the problem studied deserves the use of CART. Bootstrapped samples are used for CART and thereby the problem of small sample is taken care of. The study shows the successful application of CART. It is also to be noted that the parametric hypothesis based study (e.g., MLR or logistic regression) could have been done, but may be considered as the scope for future researchers to make a comparative study of CART, MLR and logistic regression for evaluation of job stress.

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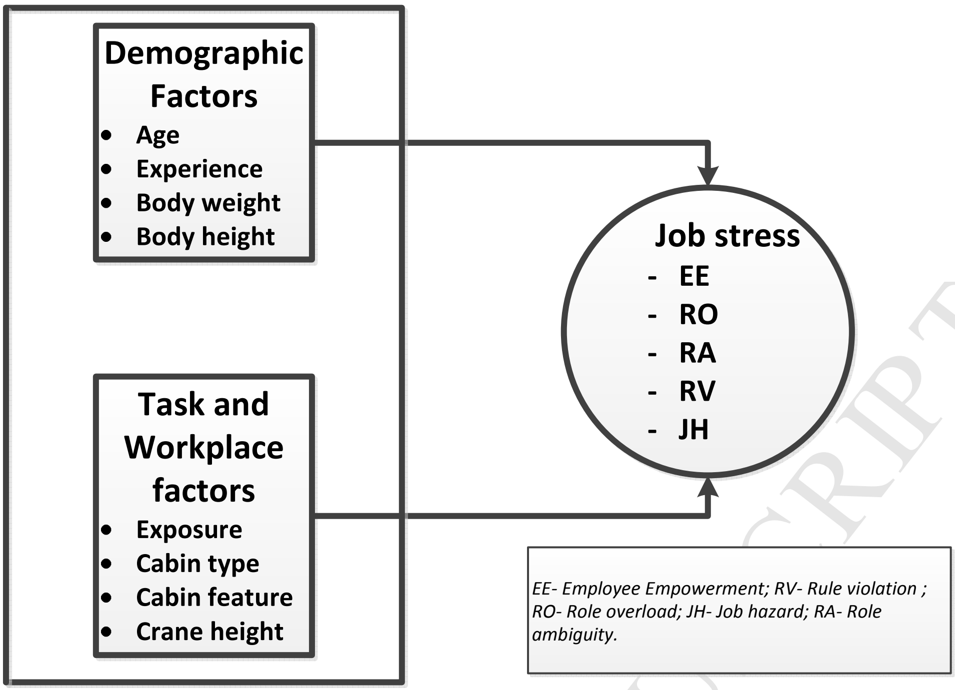

Figure 1: Relationship model for job stress with demographic, task and workplace factors

Table 1: Modified sub-scales and relevant questions used for the crane operators

Sr. No.	Sub-scales of OSI	Questions*	Cronbach alpha
1	Employee Empowerment (EE)	5, 6,7, 8, 9, 10, 11, 18, 19, 20, 21, 22, 23, 29, 30, 31, 33, 34, 40, 42	0.65
2	Role Overload (RO)	1, 12, 13, 17, 25, 28, 44, 46	0.61
3	Role Ambiguity (RA)	2, 3, 37	0.62
4	Rule Violation (RV)	4, 16, 38, 39, 45	0.62
5	Job Hazard (JH)	24	1.00

* The numbers shown are as per the original numbers of OSI [34] and Cronbach alpha represents the reliability of the items considered.

Table 2: ANOVA data structure

Predictor variable Levels	Observations	Average
Level 1	$y_{11}, y_{12}, \dots, y_{1n_1}$	$\bar{y}_1$
Level 2	$y_{21}, y_{22}, \dots, y_{2n_2}$	$\bar{y}_2$
:	:	:
Level l	$y_{l1}, y_{l2}, \dots, y_{ln_l}$	$\bar{y}_l$
:	:	:
Level L	$y_{L1}, y_{L2}, \dots, y_{Ln_L}$	$\bar{y}_L$
	Grand mean	$\bar{\bar{y}}$

Table 3: Differences in job stress across demographic factors of crane operators

Variables	Category	Percentage of employee	Mean					Total
			Employee Empowerment	Rule violation	Role overload	Job hazard	Role ambiguity	
Age	≤ 35 years	11.8	51.89	14.11	27.11	4.44	6.55	104.11
	35-45 years	69.7	52.22	14.24	26.36	4.20	6.77	103.81
	> 45 years	18.4	52.5	14.5	27.71	4.35	6.14	105.21
P-Value			0.971	0.933	0.341	0.419	0.331	0.908
Experience	≤ 5 years	52.6	52.03	14.13	26.33	4.28	6.45	103.2
	> 5 years	47.4	52.47	14.44	27.11	4.25	6.83	105.11
P-Value			0.741	0.602	0.286	0.851	0.240	0.433
Weight	≤ 65 kg	44.74	53.53	14.68	27.03	4.36	6.58	106.15
	> 65 kg	55.26	51.19	13.95	26.45	4.22	6.67	102.45
P-Value			**0.082**	0.237	0.418	0.413	0.812	0.129
Height	≤ 5 ft 6 inches	47.37	52.94	14.78	27.00	4.26	6.44	105.42
	> 5 ft 6 inches	52.63	51.60	13.83	26.42	4.26	6.80	102.92
P-Value			0.318	0.117	0.436	0.851	0.276	0.305

Table 4: Differences in job stress across Task and workplace factors of crane operators

Category	Types	Percentage of employee	Mean					Total
			Employee Empowerment	Rule violation	Role overload	Job hazard	Role ambiguity	
Exposure	24 hr.	10.52	52.00	14.13	26.25	4.38	7.50	104.25
	36 hr.	77.63	52.14	14.23	26.78	4.32	6.46	103.83
	48 hr.	11.84	53.11	14.67	27.22	3.78	7.00	105.75
P-Value			0.892	0.891	0.821	**0.023**	**0.103**	0.877
Cabin type	Type A	22.4	51.65	14.41	26.77	4.29	7.23	104.35
	Type B	77.6	52.41	14.23	26.68	4.25	6.45	104.03
P-Value			0.639	0.812	0.922	0.803	**0.045**	0.913
Cabin feature	Movable	51.3	51.64	14.21	25.38	4.15	6.71	103.10
	Static	48.7	52.86	14.35	27.03	4.37	6.54	105.16
P-Value			0.363	0.811	0.383	**0.089**	0.588	0.397
Crane height	30 ft	69.7	53.77	14.64	27.26	4.28	6.56	106.53
	40 ft	18.4	49.23	13.57	25.50	4.21	6.34	99.07
	60 ft	11.8	47.56	13.22	25.22	4.22	7.44	97.67
P-Value			**0.001**	0.180	**0.060**	0.903	0.164	**0.008**

Table 5: Importance of predictor variables

Independent Variable Importance

Independent Variable	Importance	Normalized Importance
Age	.159	100.0%
Crane Height	.092	57.8%
Cabin Feature	.085	53.5%
Operator Weight	.075	47.3%
Experience	.065	41.1%
Exposure	.054	33.9%
Cabin Type	.048	30.4%
Operator Height	.025	15.7%

Table 6: Classification table using CART

Classification

Observed	Predicted			
	1.00	2.00	3.00	Percent Correct
1.00	551	73	141	72.0%
2.00	113	1167	220	77.8%
3.00	0	151	584	79.5%
Overall Percentage	22.1%	46.4%	31.5%	76.7%

Appendix A

Modified job stress questionnaire (Modified after Srivastava and Singh [34])

Sub-scale	Original Q. No.	Question*
Employee Empowerment	5	The responsibilities for the efficiency and the productivity of the many employees are thrust upon me.
	6	Most of my suggestions are heeded and implemented here.
	7	My opinion on distribution on assignments is properly considered.
	8	I have to work with persons whom I like.
	9	My assignments are of monotonous nature.
	10	Higher authorities do care for me and respect.
	11	I get less salary in comparison to the quantum of my labour/work.
	18	My co-operation is frequently sought in solving the departmental safety and occupational \health related issues.
	19	My suggestion regarding the training programmes of the employees are given due significance.
	20	Some of my colleagues and subordinates try to defame and malign me as unsuccessful.
	21	I get ample opportunity to utilise my abilities and experience independently.
	22	This job has enhanced my social status.
	23	I am seldom rewarded for my hard labour and efficient performance.
	29	I bear great responsibilities for the progress and prosperity of this organisation.
	30	My opinions are sought in framing important policies of the organisation.
	31	Our interest and opinions are duly considered in making appointments for similar posts.
	33	I get ample opportunity to develop my aptitude and proficiency properly.
	34	My high authorities do not give due significance to my post and work.
	40	My opinion is sought in changing or modifying my job related working system, instruments and conditions.
	42	My suggestion and cooperation are not sought in solving even those problems for which I am quite competent.
Role Overload	1	I have to do a lot of work in this job.
	12	I do my work under tense circumstances.
	13	Owing to excessive work load I have to manage with insufficient no. of employees and resources.
	17	I am responsible for the future of a number of employees.
	25	I have to dispose of my work hurriedly owing to excessive work load.
	28	In order to maintain group-conformity, sometimes I have to do/produce more than the usual.
	44	I have to do such job as ought to be done by others.

	46	I am unable to carry out my assignments to my satisfaction on account of excessive work load and lack of time.
Role Ambiguity	2	The available information relating to my job, role and its outcomes are not clear.
	3	My different officers often give contradictory instructions regarding my works.
	37	It is not clear what type of work and behaviour my higher authority and colleagues expect from me.
Rule Violation	4	Sometimes it becomes complicated problem for me to make adjustment between political/group pressures and formal rules and instructions.
	16	I have to do some work unwillingly owing to certain group/political pressure.
	38	Employees attached due importance to the official instructions and formal working procedures.
	39	I am compelled to violate the routine administrative procedures and policies owing to group pressure.
	45	It becomes difficult to implement all of a sudden the new dealing procedures and policies in place of those already in practice.
Job Hazard	24	Some of the assignments are quite risky and complicated.

The response to each question is measured on a five point Likert scale: 1 – strongly disagree, 2 –disagree, 3 – undecided, 4 –agree, 5 – strongly agree.

Appendix B

CART Results

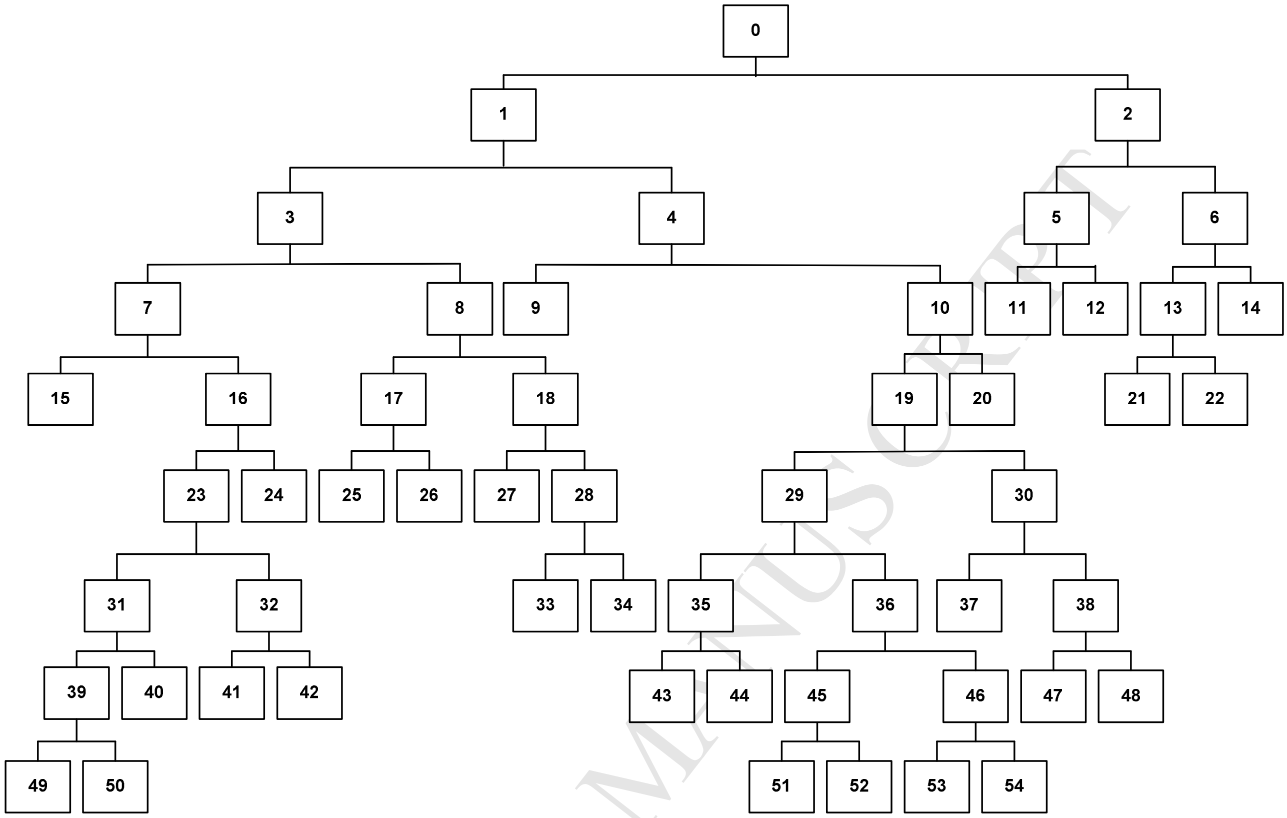

Figure B1: Classification tree map structure

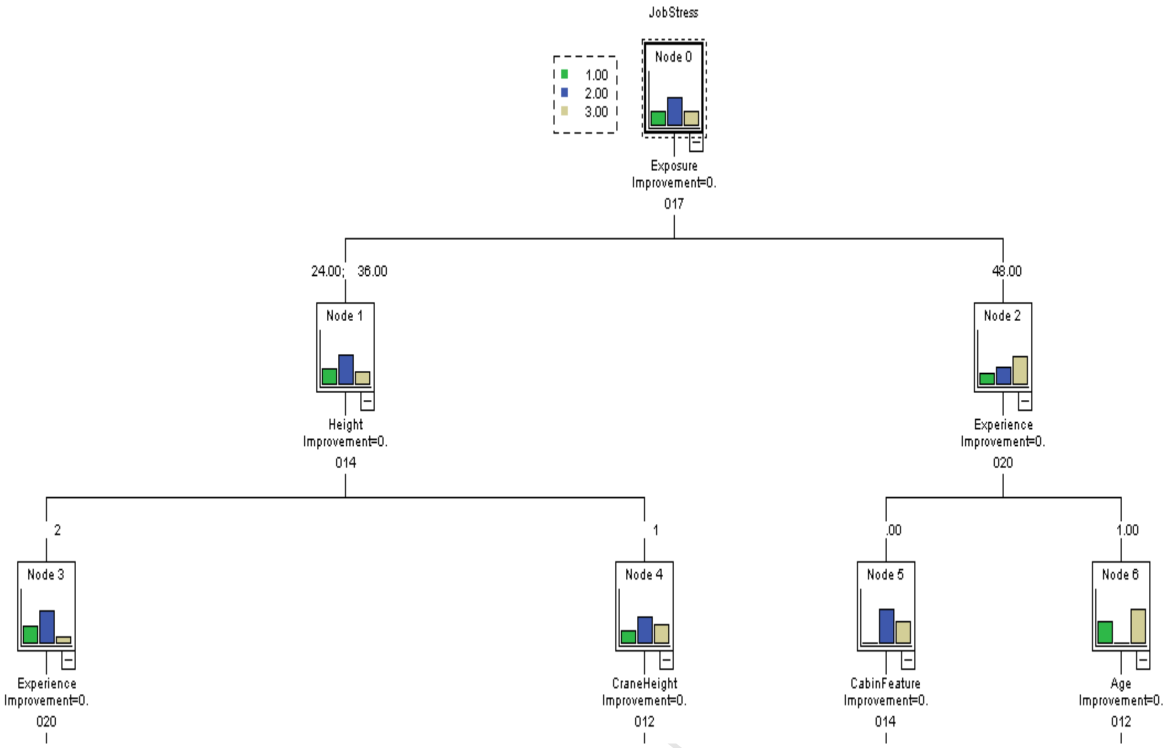

Figure B2: CART model node (1-6)

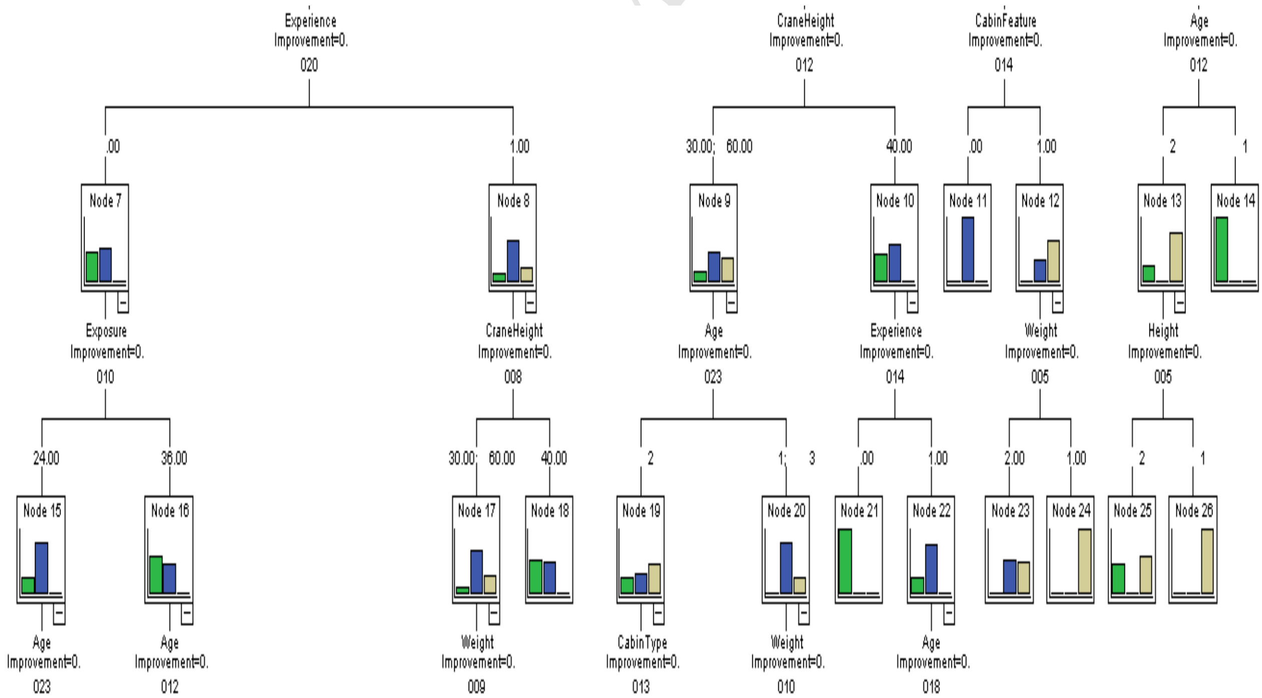

Figure B3: CART model node (7-26)

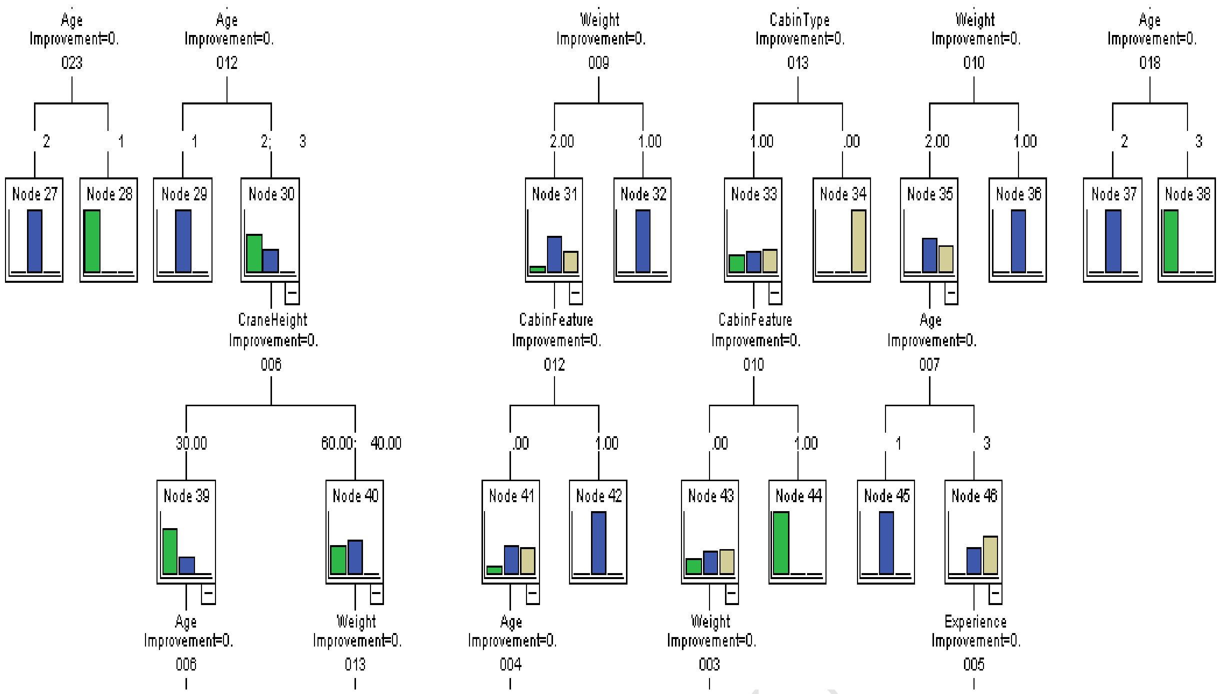

Figure B4: CART model node (27-46)

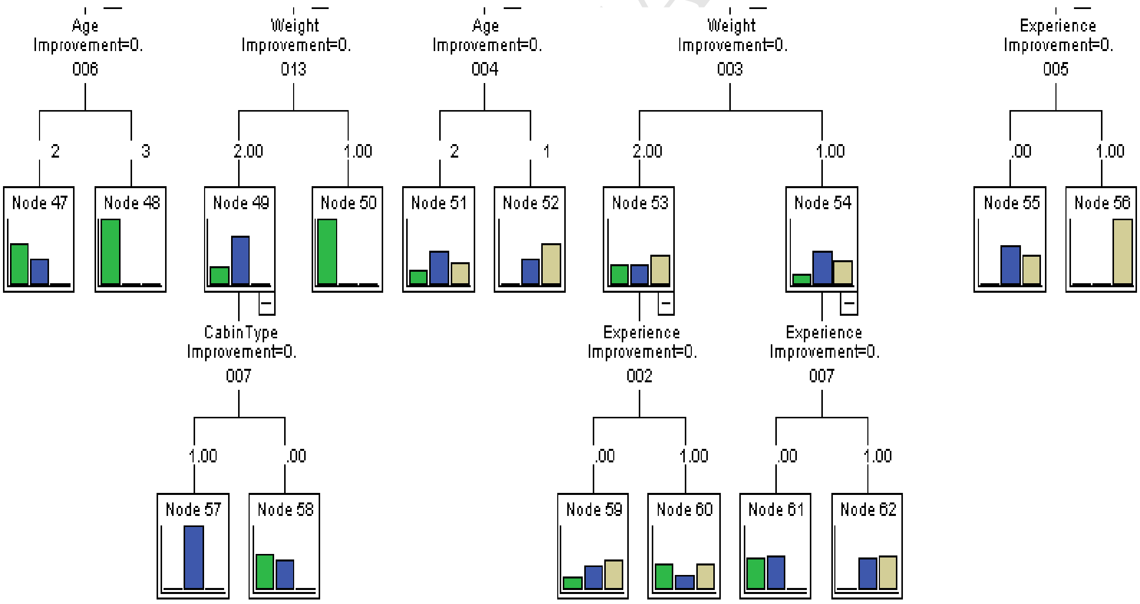

Figure B5: CART model node (47-62)