ASSESSMENT OF RESILIENT SAFETY CULTURE FOR SURAT CITY

Vedang Trivedi [#1], Ms Neetu B Yadav[*2]
[#] *Department of Civil Engineering, SNPIT & RC Umrakh, Gujarat, India*
[1]vedangtrivedi18596@gmail.com
[2]neetuyadav@yahoo.com

Abstract — **Resilient safety culture is classified by development of safety performance and the ability to identify and predict the changing shape of safety risks in construction industry. The study also found that psychological resilience has a poor impact on accident prevention under higher contextual resilience and behavioral resilience levels. Studies indicate that project risks, unexpected events and construction workers risk should be direct to achieve consistently high safety performance. It also provides construction organizations with a framework of safety efforts to evaluate their capabilities in managing site safety risks. This report discusses factors that affect resilient safety culture in construction environment. 50 factors are identified from various literatures, which affect resilient safety culture in construction environment. For this, first pilot survey is carried out and got 40 relevant factors, which influence resilient safety culture in construction environment. This study is based on questionnaire's survey and construction site data collection and analysis of this data done by RII (Relative important index) and IMPI (Important Index).**

Keywords— **Resilient safety, Construction environment, Safety culture interaction (SCI) model, Safety climate, Risk control**

I. INTRODUCTION

The nature of most accident at the construction sites shows that construction industry is unique. The construction industry have activities of construction often at outdoor under not well for safety and health purpose of workers and properties. Most of skill and unskilled labours, engineers, contractors are faces constant change in nature of work, the location of work, construction industry has major risk compare to other industry. Developing, monitoring and implementing resilience safety culture is crucial for increasing safety performance of construction industry. A safety culture aims to create a self- sustaining environment based on a compressive understanding of the cause of different work place safety performance by preventing the regular safety risk, which occurs enough to develop a standard response.

The conceptual framework of the development of safety culture in construction industry familiar as one of the dangerous industries but which can still provide a safe working environment by contributing a safe and promising career. The construction industry must have a safety culture in order to reduce number of accident, fatalities and injuries that involves worker and properties. The reputation of construction industry is replying on the expertise of implementation and management of safety.

II. OBJECTIVES

- To identify most crucial factors associated with the development of safety culture.
- To give the ranking to these factors by RII and IMPI.

III. LITERATURE REVIEW

Mohammad Tanvi Newaz et. al. 2019 Stated that the psychological contract of protection acts as an intermediary. The empirically established relationship showed that the safety climate affected workers' safety behaviour. The high level of psychological contract of safety produces a concomitant effect on safety outcomes. This research gives the relationship between management safety commitment (MSC), supervisor's safety behaviour (SSB), co-worker safety behaviour (CCB), psychological contract of safety (PCS), worker safety behaviour (WSB).

Minh Tri Trinh et. al. 2019 Said that the implementation of a safety management system and behavioural safety of site management are two aspects to assess and improve the flexible safety culture of construction projects. It also identifies the settings from which construction workers' risk tolerance may emerge when they examine the interactive effects between the dimensions of a flexible safety culture on the safety performance of construction projects.

Aziz Sadulloyevich Zikriyoev et. al. 2019 Reducing the site is called social cost: continuing agency and field work, social work protection, labour rights, technology-related content and equipment with an outsourcing style trader offering, which increases social worker protection, licensing, regulation.

Serdar Durdyev et. al. 2017 said that construction professionals (top management and government authorities) are responsible for safety performance at project sites. Thus, the practical implication of these research results is that the top management's attitude towards the importance of construction safety should be strong, as it will affect the lower level employees of the project team.

Dishant Shah et. al. 2017 Said to be the largest employment generating industry in India. The construction industry needs to address the causes of the hazards. 98% of accidents can avoid adopting appropriate safety techniques. The simplest method of adopting safety is by leaving work only to a trained competent person. Technological advances also include GPS-based tracking systems**.** GPS tracking helps to notify security officials when a worker is working at a critical height without railing or related precaution and can then inform the worker of imminent danger.

Dongping Fan1 et. al. 2015 Said management behaviour plays an important role in improving the behavioural safety performance of workers. The supervisors were the focus because they have a direct and close relationship with the workers. The hypothesized two-layer structure and interpersonal relationships between the psychological construct and the behavioural construct in the SCI model were validating.

IV. RESEARCH METHODOLOGY

Data were gathered through a questionnaire. The questionnaire is divided into two main parts. Part I is related to general information for respondent. The contractors, site engineer, consultant were further requested to answer questions pertaining to their experience in the construction industry and their opinions about the factors affecting on safety culture. Part II includes the list of the identified the factors affecting on safety culture in construction environment. There were two methods used for research work first one is RII method and second is IMPI method.

IV.I RELATIVE IMPORTANT INDEX (RII) METHOD

Based on the collected data analysis will be made to find out the most suitable methodology that can be applied for factors affecting Safety culture. The collected data were analyzed through the following statistical techniques and indices: Relative Importance Index technique: Relative Importance Index method helps to determine the relative importance of the various factors affecting on safety culture. The four-point scale ranging from 1 (less important) to 4 (extremely important) is adopted and it is transformed to relative importance indices (RII) for each factor as follows:

$$\text{RII (\%)} = \frac{4\,n4+3\,n3+2\,n2+1\,n1}{4\,(n1+n2+n3+n4)}*100$$

Where: n1, n2, n3, and n4, = the number of respondents who selected 1, for no effect; 2, for little effect; 3, for moderate effect; 4, for strong effect; n is the weighting given to each factor by the respondents (ranging from 1 to 4), A is the highest weight (i.e. 4 in this case). The RII value had a range from 0 to 4 (0 not inclusive), Higher the value of RII, more important was the factors affecting on safety culture.

The RII was used to rank (R) the different factors affecting on Safety culture. These rankings made it possible to cross-compare the relative importance of the factors as perceived by respondents (i.e. Contractors, Site engineer, Consultant). Each individual factor’s RII perceived by all respondents should be used to assess the general and overall rankings in order to give an overall picture of the Safety culture.

IV.II IMPORTANT INDEX AS A FUNCTION OF SEVERITY & FREQUENCY

FREQUENCY INDEX:

A formula is used to rank risk event based on frequency of occurrence as identified by the participants.

$$\text{Frequency Index (F.I.) (\%)} = \Sigma\, a\,(n/N) * 100/4$$

Where, a = constant expressing weighting given to each response (ranges from 1 for rarely up to 4 for always),

n = frequency of the responses, N = total number of responses.

SEVERITY INDEX:

A formula is used to rank risk event based on severity as indicated by the participants.

$$\text{Severity Index (S.I.) (\%)} = \Sigma\, a\,(n/N) * 100/4$$

Where, a = constant expressing weighting given to each response (ranges from 1 for little up to 4 for severe),

n = frequency of the responses, N = total number of responses.

IMPORTANCE INDEX:

The importance index of each event is calculated as a function of both frequency and severity indices, as follows:

$$\text{Importance Index (IMP.I.)(\%)} = [\text{F.I. (\%)} * \text{S.I. (\%)}]/100$$

V. COLLECTION OF DATA

Questionnaire was designed based on the factors affecting safety culture that influence on construction building industry identified from the literature review. The main purpose of the questionnaire was to identify the likelihood of occurrence and impact of each safety culture factors associated with the construction building industry. Subsequently, Pilot survey was carried out to validate the questionnaire. Validated questionnaire and expert survey was carried out to collect the primary data. The data will be collected from various registered Civil engineers, Consultants and Civil Contractors. Total 40 numbers of factors are identified by literature study. The questionnaire were distributed to various stakeholders by informing them regarding the purpose of the research and asking them about their willingness to participate in the research. The civil engineers, contractors and consultant showed once the initial willingness. A questionnaire was given to them. Total 102 questionnaires were distributed to different respondents in Surat District. This study received 80 responses. The total 80 number of respondents comprises of 20 contractors, 6 Consultant, 54 site engineers who participated in this field survey. The responses of them were taken for this analysis.

VI. DATA ANALYSIS

V.I Data analysis by RII (Relative Importance Index) method

The data were gathered through a survey and analysed using two different techniques: Relative Importance Index (RII) Technique and Importance Index (IMPI) technique. RII technique: The procedure used in analysing the results was aimed at establishing the relative importance of the various factor affect resilient safety culture in construction environment responsible for project failure/Delay by giving rank to the factor by RII technique. The questionnaire gave each respondent an opportunity to identify the factor that was likely to risks by giving the response “very important, important….etc.” The primary data collected from the first part of the questionnaire was analysed from the perspective of Contractor, Consultancy, and Site

Engineer. The total 80 number of respondents comprises of 20 contractors, 6 Consultant, 54 site engineers who participated in this field survey. The responses of them were taken for this analysis.

Table 1
Overall Ranking by RII Method

Rank	Factor no.	Factor affect resilient safety culture	RII
1.	1	Failure of equipment	0.893
2.	27	Poor weather condition	0.811
3.	6	Poor communication between labours and Managers	0.766
4.	11	No safety tool box meeting between manager and workers	0.747
5.	2	Shortage of manpower	0.734
6.	23	Poor maintenance of equipment	0.729
7.	15	Poor training of workers	0.710
8.	13	Improper planning and controlling	0.705
9.	37	Insufficient safety budget	0.694
10.	28	Efficiency of material and equipment	0.692
11.	32	Fatigue causes by working overtime	0.692
12.	25	Expansive over time work	0.691
13.	18	Not well educated workers	0.689
14.	34	Financial pressure	0.687
15.	14	Inaccurate demand forecasting	0.684
16.	7	Improper work	0.683
17.	4	Project locations	0.681
18.	21	Late deliveries	0.680
19.	38	Lack of protection in material transporting	0.673
20.	31	Not well educated workers	0.673
21.	12	Improper behaviour of workers(under drugs and alcohol condition)	0.673
22.	5	Not proper resource management	0.668
23.	17	Risk of project	0.668
24.	9	No supervision	0.665
25.	24	Poor physical condition of labours	0.660
26.	8	Lack of contractor experience	0.659
27.	40	Lack of skill labours	0.659
28.	19	Lack of safety signage boards	0.658
29.	29	Quality of material	0.657
30.	22	Poor awareness of safety	0.655
31.	36	Lake of emergency planed procedure	0.652
32.	20	Complex project	0.651
33.	30	Lack of personal protective equipment	0.646
34.	3	Risky reworks	0.641
35.	33	Tight schedule of work	0.632
36.	35	Lake of management commitment to safety	0.631
37.	39	Overlapping activities	0.627
38.	10	Number of construction project ongoing at same time	0.622
39.	26	Poor legislation, code and standards	0.610
40.	16	Late deliveries	0.599

V.II Data analysis by IMPI (Important index) method

IMPI technique: In this method of analysing data, for each factor, affect resilient safety culture two questions were asked to find out Frequency Index and Severity Index and on basis of this Importance index is calculated for ranking to risks. Both frequency of occurrence and severity were categorized on a four-point scale. Frequency of occurrence is categorized as follows: Always, Often, Sometimes and rarely (on 4 to 1 point scale). Similarly, degree of severity was categorized as follows: Extreme, Great,

Moderate and Little (on 4 to l point scale). The primary data collected from the second part of the questionnaire was analysed from the perspective of contractor, Consultant, site engineer. The total 80 number of respondents comprises of 20 contractors, 6 Consultant and 54 site engineers who participated in this field survey. The responses of them were taken for this analysis.

Table 2
Overall Ranking by IMPI Method

Rank	Factor no.	Factor affect resilient safety culture	FI	SI	IMPI
1.	1	Failure of equipment	79.028	77.269	61.064
2.	14	Poor training of workers	73.049	65.291	47.694
3.	34	Financial pressure	62.586	75.979	47.552
4.	40	Lack of skill labours	65.463	71.872	47.049
5.	5	Not proper resource management	64.497	69.405	44.764
6.	7	Improper work	64.557	68.380	44.144
7.	36	Lake of emergency planed procedure	65.556	67.242	44.081
8.	12	Improper behaviour of workers(under drugs and alcohol condition)	64.537	68.287	44.070
9.	37	Insufficient safety budget	68.254	64.544	44.054
10.	23	Poor maintenance of equipment	63.188	69.583	43.968
11.	24	Poor physical condition of labours	64.418	67.851	43.708
12.	32	Fatigue causes by working overtime	62.097	70.331	43.673
13.	38	Lack of protection in material transporting	64.140	67.368	43.210
14.	39	Overlapping activities	67.123	64.292	43.155
15.	18	Not well educated workers	64.147	67.183	43.095
16.	10	Number of construction project ongoing at same time	62.368	67.824	42.300
17.	19	Lack of safety signage boards	65.324	64.689	42.258
18.	21	Inaccurate demand forecasting	62.692	66.336	41.587
19.	30	Lack of personal protective equipment	60.787	68.221	41.469
20.	28	Efficiency of material and equipment	62.533	65.972	41.254
21.	17	Risk of project	64.808	63.082	40.882
22.	8	Lack of contractor experience	64.636	63.161	40.825
23.	22	Poor awareness of safety	64.127	63.505	40.724
24.	11	No safety tool box meeting between manager and workers	66.415	61.144	40.609
25.	6	Poor communication between labours and Managers	64.034	63.175	40.453
26.	3	Risky reworks	64.352	62.685	40.339
27.	20	Complex project	64.081	62.368	39.966
28.	16	Late deliveries	61.634	64.028	39.463
29.	25	Expansive over time work	65.218	60.470	39.437
30.	26	Poor legislation, code and standards	59.663	66.012	39.384
31.	31	Not well educated workers	64.683	60.860	39.366
32.	29	Quality of material	60.410	64.868	39.187
33.	33	Tight schedule of work	66.865	57.698	38.580
34.	2	Shortage of manpower	63.247	60.536	38.287
35.	27	Poor weather condition	64.689	58.929	38.120
36.	15	Workers are not likely to report accident	63.710	59.180	37.704
37.	9	No supervision	61.190	61.217	37.459
38.	35	Lake of management commitment to safety	63.280	59.193	37.458
39.	13	Proper planning & controlling	61.607	60.615	37.343
40.	4	Project location	61.138	58.545	35.793

VII. CONCLUSION

Present study is focused on identified critical factors affect resilient safety culture in construction project in Surat Gujarat region of India. Risk factors are studied based on their relative importance, frequency, severity and importance of the phases. The importance index of each factor/event was calculated as a product of both frequency and severity index of each risk. Total 40 factors were identified through literature study & experts opinion. This study received 80 responses Out of 102 numbers of respondents are from Surat city. Therefore, the response rate is 78.43%. Respondents were comprised of 20 contractors, 6 Consultant, 54 site engineers. The collected data was analysed through two different techniques:

(1) Relative Importance Index (RII)
(2) Importance Index (IMPI)

Table 3
Comparison of top 10 Risks by both methods (RII and IMPI)

Rank	Factors	Rank	Factors
1.	Failure of equipment	1.	Failure of equipment
2.	Poor weather condition	2.	Poor training of workers
3.	Poor communication between labours and Managers	3.	Financial pressure
4.	No safety tool box meeting between manager and workers	4.	Lack of skill labours
5.	Shortage of manpower	5.	Not proper resource management
6.	Poor maintenance of equipment	6.	Improper work
7.	Poor training of workers	7.	Lake of emergency planed procedure
8.	Improper planning and controlling	8.	Improper behaviour of workers(under drugs and alcohol condition)
9.	Insufficient safety budget	9.	Insufficient safety budget
10.	Efficiency of material and equipment	10.	Poor maintenance of equipment

As per both techniques, most important and common factors are “Failure of equipment”, “Poor training of workers”, “Poor maintenance of equipment” and “insufficient safety budget”.

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