A REVIEW OF SAFETY CLIMATE AND RISK-TAKING PROPENSITY IN OCCUPATIONAL HEALTH, SAFETY AND WELL-BEING IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

Studies which take safety climate as a safety monitoring tool are rarely reported. This study reports a benchmarking program to identify prominent safety management issues in three ongoing railway projects using a combination of quantitative and qualitative methods. In the quantitative aspect, the research team conducted a safety climate survey with three random samples, one sample from each ongoing project. A robust 11-factor structure of the safety climate questionnaire emerged after factor analysis. Most of the mean scores of safety climate indicators for subcontractors were below 3 (out of 4) and specific indicators were identified as in need of urgent attention.[N] The main contractor's direct labour scored similarly with subcontractors. Two main contractor management teams had to do more to take on the leadership role. The major weaknesses were the following indicators: work procedure for safety, safety compliance, safety priority over work pressure, safety cooperation and involvement, and appreciation of risk. In the qualitative aspect, the research team sought respondents' comments on current safety management practice and suggestions as to further improvement in safety performance. Content analysis showed that conflicting safety rules and inadequate training were common in the three projects, and increased supervision was proposed as the way to improve safety performance.

Keywords: *Safety Climate; Risk-taking Propensity; Occupational Health, Safety and Well-being.*

1. SAFETY CLIMATE

Based on a diversity of cues in the workplace, employees develop consistent sets of perceptions and expectations about behaviour-outcome contingencies and act accordingly (Zohar, 1980). These sets of perceptions are organizational climate when they are shared by individual employees. Safety climate is a special case of organizational climate, i.e. the organizational climate for safety. In a safety climate, the workforce is expected to carry out their tasks in a safe manner (Shen *et al*., 2015a). Relevant literature from Zohar (1980); Seo *et al*. (2004); Shen *et al*., (2015b); Choudhry *et al*., (2009); Christian *et al*., (2009); Beus *et al*., (2010); Zhang *et al*., (2015); Cheyne *et al*., (1998) shows that safety climate reflects employees' perceived importance of safe conduct in their occupational behaviour, correlates with safety initiative effectiveness, and serves as a predictor of safety activity and a leading indicator of accidents in the workplace.

More importantly, as safety climate reflects safety management practice in an organization, measuring safety climate can diagnose the organization's temporal "state of safety" at a point in time (Cheyne *et al*., 1998; Huang *et al*., 2013). In this sense, safety climate serves as a safety monitoring tool, which informs management of areas to be improved. However, rarely reported are studies which take safety climate as a safety monitoring tool, with a notable exception of Mearns *et al*. (2001). Through benchmarking nine North Sea oil and gas installations in terms of safety climate at two different points in time, Mearns *et al*. (2001) raised awareness of safety climate issues across participating organizations and prompted poor performers to take efficient improvement measures.

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[N]*A score of 2 or less indicates disagreement with a safety climate indicator, such as safe behaviour for example. The eleven indicators and the items comprising them are listed in Appendix 1.*

2. THE PROBLEM

Benchmarking organisations' safety performance with safety climate as a monitoring tool has special implications for the construction sector. At the industry level, the construction sector is plagued with a much higher than all-industry average accident rate across the globe. In order to contain the situation, researchers and practitioners have been continuously proposing safety initiatives from management, organization and technology perspectives. An important way to measure the effectiveness of these safety initiatives is through safety climate survey, which can provide cues for improvement. At the organization level, through comparing different construction projects in terms of safety climate indicators can help the organization make informed decisions regarding development and implementation of safety initiatives. This has special implications for XXX Corporation (XXXC) which oversees multiple projects simultaneously.

A seemingly plateaued project safety performance prompted XXXC management to identify predominant safety management issues in ongoing projects, and hence develop effective and efficient safety improvement initiatives. For this purpose, XXXC worked with a research team led by the first author to carry out a study. Based on prior research experience and relevant literature, the research team decided to use a combination of quantitative and qualitative methods to gather information. The quantitative method was used to measure project participants' perceptions of current safety management practice. The qualitative method was used to seek project participants' comments on current safety management practice and suggestions as to further improvement.

3. METHODS

3.1. SURVEY INSTRUMENT DEVELOPMENT

Although the definition which defines safety climate as "shared perceptions with regard to safety policies, procedures, and practices" by Zohar (2003, p.125) is well accepted, operationalization of the construct is often subject to the context in which it is to be used. In consultation with the XXXC management, the research team decided to devise a safety climate questionnaire to accommodate unique characteristics of XXX projects.

A widely-used method to develop safety climate scales is that, a set of themes are obtained through reviews of the safety literature, and after that interviews and focus groups are conducted to customize the instruments to the sponsoring organization's requirements (Flin *et al.*, 2000). After a review of the construction safety literature of Pousette *et al.* (2008); Zho*u et al.* (2011); Cigularov *et al.* (2010); Choudhry *et al*. (2009); Glendon and Litherland (2001); Molenaar *et al*. (2009) and consultation with the XXXC management, the research team proposes a consistent profile of a perceived pro-safety workplace. In this perceived pro-safety workplace,

a) the project personnel are competent to deal with risks through training and education;
b) the project personnel are conscious of what is going on in a timely manner through a flow of information;
c) the project personnel's colleagues are safety-conscious and hence provide a supportive environment for inducing and sustaining the project personnel's safe conduct;
d) the project personnel's supervisors take safety seriously and never turn a blind eye to employees breaking safety procedures;
e) the project personnel are sensitive to work pressure and would prioritize safety over production pressure;
f) the project personnel are sensitive to and would act against those work procedures which contradict safety requirements;
g) the project personnel are compliant with safety rules;
h) the project personnel can sense the effectiveness of safety measures;

i) the project personnel are cooperative and involved in safety management;

j) the project personnel are able to appreciate risks in their work;

k) the project personnel are willing to behave in a safe manner, instead of taking risks.

Three to four questions to reflect each aspect of the perceived pro-safety workplace were adapted from similar studies, including Lingard *et al*. (2010a); Lingard *et al*. (2010b); Mearns *et al*. (2003). In total, 40 items were incorporated into the questionnaire. These items were short statements, soliciting respondents' agreement with them on a 4-point scale (1 = "strongly disagree", 2 = "disagree", 3 = "agree", and 4 = "strongly agree"). Some items were negatively worded, whereas the others positively worded. The psychological measurement literature suggests that in completing a questionnaire, respondents exhibit two tendencies (Barnette, 2000). One tendency is for respondents to generally agree with survey statements more than disagree. The other tendency is that respondents provide responses in a manner that is related more to their general feelings about the subject, instead of the specific content of the item. These negatively worded items were used to guard against these tendencies.

There were three sections in the questionnaire. The first section was to gather respondents' demographical information. The second part was a safety climate scale to measure respondents' safety climate perceptions. The last part using open-ended questions was to seek respondents' comments and suggestions. After pilot study, with the finalized questionnaire the research team conducted three random sample surveys on three separate ongoing projects.

3.2. SAMPLE

With assistance of the main contractors, the research team secured 336, 157 and 414 valid responses respectively from three projects. Among the respondents were both management and frontline staff.

3.3. DATA ANALYSIS

With the safety climate scale, the research team carried out exploratory factor analysis (EFA), and found a rather robust 11-factor structure. With the 11 indicators the research team made comparisons between projects and organizations involved in each project using ANOVA and *t*-test procedures. The questionnaire also elicited respondents' comments on current safety management approach and suggestions for further safety improvement. Conventional content analysis procedures of Hsieh and Shannon (2005) were used to analyse the comments and suggestions, and find out common issues across projects and peculiar issues specific to each project. The next section is to present the results in sequence.

4. RESULTS

4.1. THE EMERGENT 11 INDICATORS OF THE SAFETY CLIMATE SCALE

EFA was conducted with the aggregate sample, and 11 factors (indicators or dimensions) emerged, including competence, communication, safety supportive environment, pro-safety supervisory leadership, safety priority over work pressure, work procedure for safety, safety compliance, safety effectiveness, safety cooperation and involvement, appreciation of risk, and safe behaviour. They were in accordance with the 11 features of the perceived pro-safety workplace as mentioned earlier.

The indicator of competence refers to respondents' feeling that they are competent to deal with risks through training and education. The indicator of communication refers to the phenomenon that respondents are informed of what is going on in a timely manner through the free flow of information. The indicator of safety supportive environment refers to respondents' feeling that their colleagues are safety-conscious and hence provides a supportive environment for inducing and sustaining project personnel's safe conduct. The indicator of pro-safety supervisory leadership refers to respondents' feeling that their supervisors take safety seriously and never turn a blind eye to employees breaking safety procedures. The indicator of safety priority overwork pressure refers to the phenomenon that respondents are sensitive to work pressure and would prioritize safety over production pressure. The indicator of work

procedure for safety refers to the phenomenon that respondents are sensitive to and would act against those work procedures which contradict safety requirements. The indicator of safety compliance refers to the phenomenon that respondents are can recognize and follow safety rules and procedures as proper. The indicator of safety effectiveness refers to respondents' realization that safety measures are effective in bringing down unsafe behaviours. The indicator of safety cooperation and involvement refers to the phenomenon that respondents are cooperative and involved in safety management practice. The indicator of appreciation of risk refers to respondents' acknowledgement that they have to do some jobs with taking risks. The indicator of safe behaviour refers to respondents' feeling that they would behave in a safe manner, instead of taking risks. The 11 indicators and related measurement items are shown in Appendix 1.

4.2. RATING OF ORGANISATIONS IN TERMS OF SAFETY CLIMATE INDICATORS

The research team compared the main contractor and subcontractors in terms of the 11 safety climate indicators. Table 1 shows the results and mismatches among project personnel's views on safety management practices on site. Specifically, the main contractor management scored significantly higher than the main contractor's direct labour in terms of five indicators (i.e. competence, communication, safety effectiveness, safety cooperation and involvement, and appreciation of risk). This suggests that across the three surveyed projects, the main contractors' frontline staff felt less competent to deal with safety issues, and were less likely to feel the effectiveness of safety initiatives. To the main contractors' frontline staff, there is insufficient communication about safety matters, their involvement in safety management is limited, and they are not confident that they can recognise and identify hazards as proper. The main contractor, including management and direct labour, scored significantly higher than subcontractors in terms of five indicators (i.e. competence, safety supportive environment, safety priority over work pressure, safety effectiveness, and appreciation of risk). This suggests that future interventions to upgrade subcontractors' safety performance should focus on strengthening their self-efficacy in dealing with safety issues, instituting a buddy system at the work crew level, reducing progress pressure, building up their capacity to identify risks. Through these measures they are more likely to feel the effectiveness of safety initiatives.

Table 1: Comparison between the Main Contractor and Subcontractors based on the Mean Values of Safety Climate Indicators

Indicators	Main contractor (management)	Main contractor (workers)	Main contractor (management + worker)	Subcontractors
Competence	3.3	3.1	3.2	3.1
Communication	3.1	2.9	3.0	2.9
Safety supportive environment	3.4	3.2	3.3	3.1
Pro-safety supervisory leadership	3.0	2.9	3.0	2.9
Safety priority over work pressure	3.0	2.9	2.9	2.8
Work procedure for safety	2.8	2.9	2.9	2.8
Safety compliance	2.9	2.8	2.9	2.8
Safety effectiveness	3.0	2.8	3.0	2.8
Safety cooperation and involvement	3.0	2.9	2.9	2.9
Appreciation of risk	2.8	2.6	2.7	2.6
Safe behaviour	3.1	3.0	3.1	3.0
Average	*3.0*	*2.9*	*3.0*	*2.9*
Sample size (n)	*171*	*117*	*288*	*631*

Note: Indicators were measured on a 4-point Likert scale (1 = "strongly disagree", 2 = "disagree", 3 = "agree", and 4 = "strongly agree").

In order for XXXC to grasp the difference in perceptions of safety management practice between organisations, the research team rated organisations in terms of each of the 11 emergent safety climate indicators. Specifically, the top 30% organisations on each indicator were labelled as "can improve", and

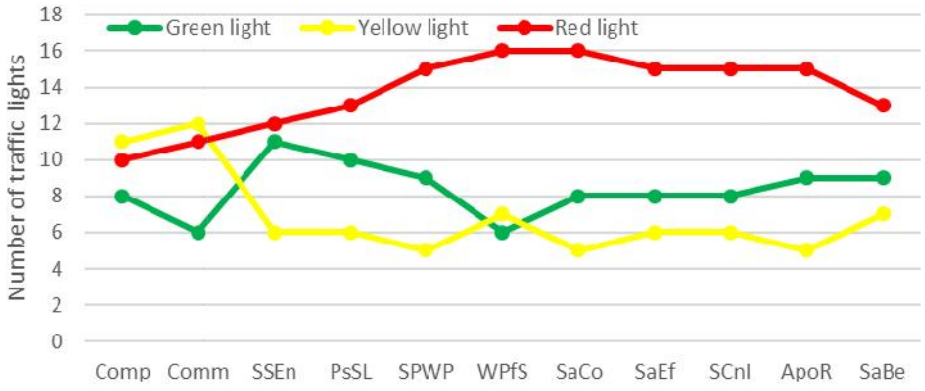
accordingly assigned green traffic lights. The next 20% organisations were classified as “need to improve”, and assigned yellow traffic lights. The remaining 50% organisations were labelled as “urgent improvement needed”, and assigned red traffic lights. Table 2 shows the ratings of organizations on Project YYYY against other organizations in other projects.

In general, most organisations were at a similar performance level in terms of two indicators (i.e. competence and communication), and their scores were around three. However, in terms of other two indicators (i.e. safety supportive environment and pro-safety supervisory leadership) there was a clear divisive line between good and poor performers. In other words, these two indicators are more capable of differentiating good and poor performers than other indicators. This also suggests that pro-safety supervisory leadership and safety supportive environment are key weaknesses of the poor performers, consonant with findings in other studies in Hong Kong and Australia where the role of the supervisor was found to be crucial in promoting safe behaviour (Lingard *et al*., 2009; Choudhry *et al*., 2008). In terms of the indicator of work procedure for safety, more organisations were labelled as “need to improve” than those labelled as “can improve”, which is contradictory to the expected outcome. This suggests that most organisations gave it a lower rating, i.e. most organisations would follow work procedures even though these work procedures contradict safety requirements. The trend can be seen in Figure 1, which features the number of traffic lights across safety climate indicators.

Table 2: Rating of Organisations on Project YYYY against Other Organisations

	Indicators	Sub5	Sub1	Sub8	Sub4	Sub9	Maincontr managemt	Sub2	Sub6	Maincontr labour	Sub3	Sub7
Safety values	Competence	🟢	🟡	🔴	🔴	🔴	🟡	🟡	🔴	🔴	🔴	🔴
	Communication	🔴	🔴	🔴	🔴	🟡	🟡	🟢	🔴	🔴	🔴	🔴
	Safety supportive environment	🔴	🟢	🔴	🔴	🟡	🟢	🟡	🔴	🔴	🔴	🔴
Safety priority	Pro-safety supervisory leadership	🟢	🟢	🟢	🔴	🟢	🟡	🔴	🔴	🟡	🔴	🔴
	Safety priority over work pressure	🟢	🟡	🟢	🟢	🔴	🟢	🔴	🔴	🟡	🔴	🔴
Risk-taking Engagement Procedures	Work procedure for safety	🟢	🟢	🟢	🟢	🟡	🔴	🔴	🔴	🟡	🔴	🔴
	Safety compliance	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🟡	🔴	🔴	🔴
	Safety effectiveness	🟢	🟢	🟡	🟡	🔴	🟡	🔴	🔴	🔴	🔴	🔴
	Safety cooperation and involvement	🟢	🟡	🔴	🟢	🟢	🟡	🔴	🔴	🔴	🔴	🔴
	Appreciation of risk	🟢	🟢	🟢	🟢	🟢	🟡	🔴	🔴	🟡	🔴	🔴
	Safe behaviour	🟡	🟡	🟢	🟡	🟢	🟢	🔴	🟢	🟡	🔴	🔴
	Sample size (n)	9	7	8	13	8	69	25	7	53	20	7

Note: 🔴 Urgent improvement needed; 🟡 Need to improve; 🟢 Can improve.



Comp: Competence; Comm: Communication;
SSEn: Safety supportive environment; PsSL: Pro-safety supervisory leadership;
SPWP: Safety priority over work pressure; WPfS: Work procedure for safety;
SaCo: Safety compliance; SaEf: Safety effectiveness;
SCnI: Safety cooperation & involvement; ApoR: Appreciation of risk;
SaBe: Safety behaviour

Figure 1: Number of Traffic Lights across Safety Climate Indicators

5. RESPONDENTS' COMMENTS ON CURRENT SAFETY MANAGEMENT APPROACH

Respondents were asked for comments on current safety management approaches on XXXC construction projects. 14 categories emerged across conventional content analysis of comments from the aggregate sample, and they were *rules*, *training*, *pace of work*, *engagement*, *blame culture*, *supervision*, *leadership*, *resources*, *tight programme*, *bureaucracy*, *safety priority*, *communication*, *incentive and penalty schemes*, and *practicability of safety interventions*. Table 3 shows the convergence and divergence in respondents' comments on safety management approach on their sites, based on the emergent categories.

Table 3: Respondents' Comments on the Current Safety Management Approach

Projects	**YYYY**	**VVVV**	**WWWW**
Convergence	Rules Training	Rules Training	Rules Training
Divergence	Pace of work Engagement Blame culture Supervision Leadership	Resources	Tight programme Engagement Bureaucracy Safety priority Communication Incentive and penalty scheme Practicability of safety interventions

Across the three projects, project personnel were complaining about inconsistent rule enforcement regarding safety policies. For example, respondents in YYYY reported that at least two safety standards are in operation, i.e. XXXC's safety standard and the main contractors' safety standards. The clash between these two standards and associated work practices often frustrated frontline staff. Besides, respondents were of the opinion that more safety trainings can improve safety performance.

Unlike respondents in other two projects, those respondents in Project VVVV expected allocating more resources to safety management, from PPE to monetary incentives. Respondents from Project YYYY and WWWW attributed poor safety performance to tight programme and limited engagement in safety

management practice. Respondents in Project YYYY reported that there is a blame culture in accident investigations, and a lack of frontline supervisory leadership and supervision. Respondents from Project WWWW complained that safety management practice has been bureaucratized, safety is often sacrificed in case of tight programme, and there should be a communication channel between management and frontline workers. Impressively, they reminded management that only those interventions which meet the needs from the bottom can be effective.

6. RESPONDENTS' SUGGESTIONS FOR SAFETY PERFORMANCE IMPROVEMENT

Respondents' suggestions as to how safety performance could be improved were noted. 14 categories emerged from conventional content analysis of suggestions regarding safety performance improvement from respondents, and they were *supervision, rules, training, engagement, leadership, pace of work, resources, management commitment, communication, human resource management, incentive and penalty schemes, tight programme, safety priority*, and *near miss reporting*. Table 4 shows the convergence and divergence in respondents' suggestions with regard to improving safety performance.

Table 4: Respondents' Comments on the Current Safety Management Approach

Projects	YYYY	VVVV	WWWW
Convergence	Supervision	Supervision	Supervision
Divergence	Rules	Rules	Tight programme
	Training	Training	Resources
	Engagement	Engagement	Communication
	Leadership	Management commitment	Human resource management
	Pace of work	Communication	Incentive and penalty scheme
	Resources	Human resource management	Safety priority
		Incentive and penalty scheme	Near miss reporting

Respondents in all the three projects suggested that more supervision should be strengthened if safety performance is to improve.

Unlike respondents from other two projects, respondents in Project WWWW noted the importance of near miss reporting in safety performance improvement. Respondents in both Project YYYY and VVVV regarded consistent rule enforcement and increased worker engagement as the key to further improving safety performance. Unlike respondents in Project VVVV who were anticipating more commitment from the main contractor's top management, respondents in Project YYYY expected to strengthen supervisory safety leadership. Progress pressure and resources, PPE in particular, were mentioned by respondents from both Project YYYY and WWWW as primary hurdles to safety performance improvement. Respondents from both Project VVVV and WWWW suggested increased communication about safety matters, more incentives, and employment of experienced project personnel.

7. CONCLUSION

Safety climate refers to employees' shared perceptions of safety policies, procedures and practices. It reflects the value of safety in organizations' daily operations and organizations' temporal "state of safety". From this perspective, it serves as a safety monitoring tool. Through safety climate survey, an organization can detect areas to be improved. If the safety climate survey is carried out across comparable organizations, the results can help their superior organization formulate organization-specific effective and efficient safety initiatives. This has special practical implications for clients overseeing multiple projects simultaneously in the construction sector, which is notorious for poor safety performance.

This study reports a benchmarking program to identify prominent safety management issues in ongoing XXXC projects using a combination of quantitative and qualitative methods. In the quantitative aspect, the

research team conducted a safety climate survey with three random samples, one sample from each ongoing project. A robust 11-factor structure of the safety climate questionnaire emerged after factor analysis. Most of the mean scores of safety climate indicators for subcontractors was below 3 (out of 4) and specific indicators were identified as in need of urgent attention. The main contractor's direct labour scored similarly with subcontractors. Two main contractor management teams had to do more to take on a leadership role. The major weaknesses were the following indicators: *work procedure for safety, safety compliance, safety priority over work pressure, safety cooperation and involvement,* and *appreciation of risk*. In the qualitative aspect, the research team sought respondents' comments on current safety management practice and suggestions as to further improvement in safety performance. Content analysis showed that conflicting safety rules and inadequate training were common in the three projects, and increased supervision was proposed as the way to improve safety performance.

The limitation is that, this study used a cross-sectional design. It was unable to reveal changes in safety climate indicators before and after a project implement safety initiative, although it could show weaknesses of one project against others. Furthermore, objective accident data at both the project and organization levels had not been collected, which makes it impossible to link subjective safety climate perceptions to objective accident rate.

Despite the limitations, this study makes contribution in using safety climate as a monitoring tool, which helps clients formulate project and organization specific safety improvement measures across ongoing multiple projects.

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Appendix 1: Indicators of the Safety Climate Scale

	Indicators	Items
Safety values	Competence	I am clear about what my responsibilities are for health and safety.
		The induction training I have received at the Project covers all the health and safety risks associated with the work for which l am responsible.
		I fully understand the health and safety risks associated with the work for which I am responsible.
	Communication	I am satisfied with the way I am kept informed about what takes place on the Project.
		Workers at the Project site are consulted about safe work methods.
		Workers are told when changes are made to the working environment on a job site.
		Main contractor management provides safety training when employees change their work tasks.
Safety priority	Safety supportive environment	Safety comes from worker co-operation.
	Pro-safety supervisory leadership	As long as there is no accident, the supervisor doesn't care how the work is done.
		The supervisor only keeps track of major safety problems and overlooks routine problems.
		As long as work remains on schedule, the supervisor doesn't care how this has been achieved.
	Safety priority over work pressure	There is sometimes pressure to put production before safety at the Project by main contractor.
		Under pressure I need to ignore normal safety requirements at the Project for the sake of getting the work done.
Procedures	Work procedure for safety	Around here, there are lots of safety procedures that don't really apply to the particular areas or circumstances in which they are supposed to be used.
		There are so many procedures that interfere with doing a job safely.
	Safety compliance	On this Project, people are often uncertain about what the safety procedures are for the work they do.
		Safety procedures tend to be too vague and general to apply in specific situations.
Engagement	Safety effectiveness	Our daily routines don't show that safety is an important value.
	Safety cooperation and involvement	I am not given enough time to get the job done safely on the Project.
		At the Project main contractor management officially encourages open communication, but in reality most people know not to speak up and 'rock the boat'.
		Some employees may hesitate to speak up about safety concerns for fear of retaliation.
Risk-taking	Appreciation of risk	Some jobs here are difficult to do safely.
	Safe behaviour	Sometimes it is necessary to take risks to get the job done.
		If I didn't take risks, the job wouldn't get done.