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## Safety leadership: application in construction site

### Leadership nella sicurezza: esempi di applicazione nella cantieristica

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**ABSTRACT.** *The extant safety literature suggests that managerial Safety Leadership is vital to the success and maintenance of a behavioral safety process. The current paper explores the role of Managerial Safety Leadership behaviors in the success of a behavioral safety intervention in the Middle-East with 47,000 workers from multiple nationalities employed by fourteen sub-contractors and one main contractor. A quasi-experimental repeating ABABAB, within groups design was used. Measurement focused on managerial Safety Leadership and employee safety behaviors as well as Corrective Actions. Data was collected over 104 weeks. During this time, results show safety behavior improved by 30 percentage points from an average of 65% during baseline to an average of 95%. The site achieved 121 million man-hours free of lost-time injuries on the longest run.*

*Stepwise multiple regression analyses indicated 86% of the variation in employee safety behavior was associated with senior, middle and front-line manager's Safety Leadership behaviors and the Corrective Action Rate. Approximately 38% of the variation in the Total Recordable Incident Rate (TRIR) was associated with the Observation rate, Corrective Action Rate and Observers Records of managerial safety leaders (Visible Ongoing Support). The results strongly suggest manager's Safety Leadership influences the success of Behavioral Safety processes.*

**Key words:** *behavioral safety, Safety Leadership, Corrective Actions, TRIR, multiple regression.*

**RIASSUNTO.** L'attuale letteratura sulla sicurezza suggerisce il ruolo centrale che la Leadership riveste per il successo ed il mantenimento nel tempo di un processo di sicurezza comportamentale. Il presente articolo esplora il ruolo dei comportamenti di Safety Leadership illustrando il successo ottenuto da un progetto di B-BS realizzato in Medio-Oriente, con 47000 lavoratori di diverse nazionalità legati all'azienda da rapporti di lavoro diretti o in subappalto. È stato utilizzato un disegno quasi sperimentale con misure ripetute (ABABAB) entro i gruppi. La misurazione dei comportamenti si è focalizzata sulla Safety Leadership dei manager, sui comportamenti dei lavoratori e sulle Azioni Correttive. I dati sono stati raccolti nel corso di 104 settimane. In questo lasso di tempo, i risultati mostrano che i comportamenti di sicurezza sono aumentati di 30 punti percentuali passando da una media del 65% (baseline) ad una media del 95%. Come miglior risultato, il sito industriale ha raggiunto un totale di 121 milioni di ore-uomo consecutive senza infortuni determinanti la perdita di ore lavorative. L'analisi della regressione multipla secondo il modello Stepwise ha indicato che l'86% della variazione nel comportamento dei lavoratori è associata sia ai

comportamenti di Safety Leadership dei senior, middle manager e dei capitulo, sia alle Azioni Correttive. Approssimativamente, il 38% della variazione nel Tasso di Incidenti Registrabili Totali (TRIR) è associato al tasso di osservazioni, al tasso di Azioni Correttive ed alle registrazioni degli osservatori in presenza dei safety leaders (Visible Ongoing Support). In conclusione, i risultati ottenuti suggeriscono in maniera decisa che la Safety Leadership dei manager influenza il successo dei processi di sicurezza comportamentale.

**Parole chiave:** sicurezza comportamentale, Safety Leadership, Azioni Correttive, TRIR, regressione multipla.

#### Introduction

Top performing companies express high commitment to safety by developing a process in which the workforce can participate, and which can be implemented and monitored so both management and the workforce can receive feedback (1). A systematic Behavioral Safety process fulfils these conditions. The intention is to focus worker's attention and action on their safety behavior to avoid injury. Interventions are aimed entirely upon the observable interactions between safety behavior and the working environment.

Behavioral Safety attempts to identify those unsafe behaviors implicated in the majority of injuries. These behaviors and/or their proxies (e.g., hoses left lying across walkways) are developed into specific behavioral checklists. Trained observers use these to monitor and record people's work behavior on a regular basis (e.g., daily). Derived from the observation results, 'Percent safe' scores provide feedback so people can track their progress against self-set, assigned or participative improvement goals (2). Feedback mechanisms include verbal feedback at the point of observation, graphical charts and/or written performance summaries so corrective actions can be taken (3, 4). Results indicate significant reductions in injury rates are possible within a relatively short time (5) with the impact lasting for many years (6).

Those companies implementing Behavioral Safety possess a high degree of organizational commitment to safety (1). However, the commitment of individual man-

ager to the organization's safety goals and the Behavioral Safety process is a significant factor (7). Managers need to provide the necessary resources and actively support the process. In many instances this does not occur.

### 1.1 Management's Commitment

Managerial commitment is defined as "engaging in and maintaining behaviors that help others achieve a goal" (8). Broadly speaking, measurement can be undertaken in two ways: Direct questions are asked of managers (9) or their commitment behaviors are monitored (10). Not many managers admit they are uncommitted to safety when asked, whereas behavior provides the ultimate proof of commitment (10, p.4). An extensive search of the psychological, managerial and safety literatures reveal the existing managerial commitment evidence is almost entirely based on the findings of numerous safety climate perception surveys (e.g. 11) with very little empirical work assessed the actual impact of managerial commitment behaviors on safety performance (e.g. 12, 13). Perceptual data obtained in the UK construction industry suggested the impact of managerial commitment to safety could exert an impact of approximately 51% on a Behavioral safety process (14).

### 1.2 Management Levels

Although unclear, the available evidence suggests different management levels exert different effects on employee behavior. For example, in a Dutch questionnaire study of 207 workers on 15 construction sites, Andriessen (15) found that senior managers exert a greater influence on employee motivation to behave safely than supervisors do. Conversely, Simard and Marchand's (16, 17) Quebec questionnaire survey with 23,615 production workers, suggests supervisors exert a greater influence on employee behavior than senior plant managers do. These two examples suggest the effects of management's commitment are likely to be moderated by situational aspects such as the prevailing safety culture (18), type of setting (19) and type of organizational structure (20). In a Behavioral Safety study in a British Nickel Refinery, Cooper (8) found that different management levels exerted independent and cumulative effects on employee safety behavior. Senior management commitment played a primary role in shaping employee behaviors and a secondary role by shaping lower management behavior that in turn influenced employee behavior.

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### Study Aims

The purpose of the current study was to investigate the impact of managerial Safety Leadership support on employee safety behavior and incident rates in a Middle-East construction setting.

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### Method

#### Participants and Setting

47,000 Third-Party Nationals from India, Indonesia, Malaysia, Nepal, Philippines, Sri Lanka, Turkey and the

UAE were involved in the construction of 2 X LNG Super Trains, an Employee Camp for 50,000 workers, LNG Storage Tanks & Jetty.

The workforce were employed by Fourteen Sub-contractors from India, Ireland, Italy, Nepal, the UAE, and USA working for a Japanese / French Joint venture. In other words, the project involved multiple contractors and multiple nationalities in a dynamic setting (19). The size of the project was equivalent to 100 US football fields combined, with the wiring for 1 X Train alone stretching in excess of 3000 miles (i.e. longer than the distance between New York and Los Angeles!).

### Quasi-Experimental Design

While data were collected continuously over 104 weeks on a daily basis, consecutive interventions were implemented using an AB-AB design within each sub-contractor project. Not all sub-contractors were on-site at the same time, but the sequence of interventions included: 1) Baseline 1 (4 weeks); 2) Intervention 1 (approx. 26 weeks); 3) Return to Baseline 2 (4 weeks); (4) Replication Intervention (approx. 26 weeks); and so on, until their contract was complete and they left the site.

### Behavioral Safety Measures

The primary measurement variables focused on employee safety behavior (percent safe) and managerial leadership behavior (percent leadership support), both of which are categorized as safety compliance data. Total Recordable Injury Rates (TRIR) comprised the secondary variable used to assess the efficacy of the interventions, categorized as safety performance data.

### Safety Behavior Checklist

Behavioral safety checklists for each contractor were developed by the behavioral safety facilitators with oversight from the author and colleagues, based on the construction activities to be undertaken. Each contained a maximum of 20 behaviors (e.g., Personnel are not manually handling loads that are too heavy) pertaining to the work area of interest. These were placed into various categories (e.g., Housekeeping, Personal Protective Equipment, etc.) to facilitate analyses and feedback.

Each checklist contained three columns: Safe, Unsafe, and Unseen that observers used to record the results of their observations (see procedural section below for observation details). Any particular behavior recorded as *safe* meant that everyone observed was performing that behavior safely. Any one person observed performing an unsafe behavior resulted in that behavior being scored unsafe (21). A frequency count of the number of persons performing a particular unsafe behavior determined the recording of unsafe behavior. The total number of safe behaviors recorded were divided by the sum of the total safe and unsafe behaviors recorded, and multiplied by 100 to calculate an Observed Percent Safe score (the primary dependent variable in this study). The unseen column was marked when a particular behavior did not occur during the 15 minute observation tour (the project team analysed these to remove infrequently recorded behaviors from subsequent intervention checklists). Project facili-

tators entered daily observation data into an online behavioral safety computer database (22) when they received the completed behavioral checklists from the observers. The database contained an exact copy of each contractor's checklists, by trade, with corresponding data entry fields in the safe, unsafe, and unseen columns. Once entered, the program automatically calculated a percent safe score (i.e., total safe/ (total safe and unsafe), multiplied by 100). The program was used to generate weekly feedback reports for each contractor/trade group that were presented to the workforce at weekly 'toolbox' talks.

### Managerial Leadership Checklists

Senior, Middle and front-line managers themselves identified their Safety Leadership behaviors. The resulting checklists did not change throughout the duration of the study, with each containing between 10 and 14 items (See Figure 1 for an example). The managers were trusted to complete these once per week on a self-report basis.

### Visible Ongoing Support Checklists

Each and every week as a cross-check on the managerial self-reports of Safety Leadership, observers were asked to record the amount of contact they had experienced with each of the different management levels. Observers were also asked to indicate the type of support provided by their project facilitator and from their colleagues. This measure was termed 'Visible Ongoing Support (VOS).

### Injuries

The Total Recordable Injury Rate (TRIR) was used as the primary outcome measures to assess the effectiveness of the Behavioral Safety process. The site calculated these based on the number of incidents per 200,000 hours worked.

### Observer Recruitment & Training

Observers were recruited from within the ranks of each contractor workforce, by their managers. A target of 2 percent of the entire workforce was set, to try to achieve a ratio of observers to workforce of 1:50. This meant we sought a total of some 950 observers (in fact we recruited and

trained 1,500, giving a ratio of 1:31). Each observer was trained by the contractor facilitators, as well as the author and colleagues when they were on site. Observers were taught how to observe, give verbal feedback to individuals, set participative improvement goals with workgroups and conduct weekly workgroup feedback sessions on a one-day training course. A one-week practice period was used to identify observers not completing the checklists correctly, with appropriate coaching being given, where required.

### Implementation of the Behavioral Safety Process

To begin, we held a 'lessons learnt' review exercise of different Behavioral Safety processes operated by some of the different contractors. From this a process was developed that would build on the positives and address the areas of opportunity identified (one of the major findings was a lack of managerial support built in to the process). This resulted in a planned sequential roll-out of the Behavioral Safety process across all the contractors, with planned milestones for achievement for each individual contractor. One hour 'Sell & Tell' briefings were held with the management of all the contractors (including the Joint Venture management).

Broadly, the time-frame of the Behavioral Safety roll-out and execution activities were:

1. Trained Project coordinators – *Five days.*
2. Developed Behavioral Checklists – *Four Weeks.*
3. Conducted Managerial Alignment Sessions to obtain commitment – *6 weeks (at 2 hour sessions).*
4. Trained some 1500 Observers – *Target of 2% of entire workforce.*
5. Established Baseline performance – *1<sup>st</sup> four weeks of observations.*
6. Set work crew improvement targets – *Determined by Baseline Scores.*
7. Gave feedback – *Daily (verbal) / Weekly(written) / monthly Managerial Summaries.*
8. Developed Publicity Infrastructure – *Developed Behavioral Safety Site Induction package / Posters/ Newsletters, etc.*
9. Reviewed Process and adapted according to the Construction program – *Changed checklists to suit construction program and trained new observers.*

A comprehensive training document outlining roles & responsibilities, implementation activities and a planned implementation schedule was developed and provided to the main contractor and all sub-contractors to help facilitate self-sufficiency in the training of project administrators and observers. Specific metrics to monitor the roll-out and success of the entire process across all 14 contractor projects were also developed. These were reported monthly to the site safety committee. These included

Item	Yes	No	N/A
<b>Category 1: People support</b>			
1 Participated in a job start meeting			
2 Discussed safety performance with employees (one to one)			
3 Discussed safety with line management and / or client			
4 Reviewed application of a JSA (at any level)			
5 Corrected an unsafe act			
<b>Category 2: System support</b>			
6 Reviewed Hit list of corrective actions			
7 Developed plans for corrective actions			
8 Ensured TWT corrective actions were closed by agreed date			
9 Reviewed safety progress with management team			
10 Reviewed an incident investigation report (as required)			
<b>Category 3: Training support</b>			
11 Conducted safety related coaching			
<b>Category 4: Observer Support</b>			
12 Promoted daily observations			
13 Offered support to an observer			
14 Assisted an observer in providing team feedback			
<b>Total</b>			
Total %Score: Total(Total Yes / (Total Yes + Total No )) * 100: ___%			

Figure 1. Example managerial Safety Leadership Index

- Total Site Manpower,
- Number of trained coordinators / observers per contractor
- Ratio of Observers to Personnel (Target = 1:50).
- Ratio of Observations Expected/ Received
- % Safe Score,
- % Safety Leadership Scores for senior, middle and front-line managers
- % VOS (Workers record of safety support received from management)
- 5 Best / Worst Scoring Behaviors,
- the Corrective Action Completion Rate
- Monthly 'Lessons Learnt' Meetings with all contractors

**Results**

The number of the various checklists returned and corrective actions completed with associated percentage rates were as follows:

**Table I. Number of measures returned and associated percentage rates**

Indicator	Number	% Rate
Safety Behavior Observations	2.3 million	84.67
Senior Managers Leadership Checklists	36, 215	90.36
Middle Managers Leadership Checklists	83,731	87.58
FLM Leadership Checklists	58,659	90.15
VOS checklists	36,215	86.91
Corrective Actions Completed	2,973	88.8
Observer to Worker ratio (2% target)		3.13%

**Safety Behavior Results**

The graph below illustrates safety behavior improved by some 30 percent over a 2 year period across all 14 contractors, for all activities. The data is aligned and collated in 'real-time', so reflects actual percent safe scores as the different contractors came and went on site.



**Figure 2. Behavioral improvement across all 14 contractors**

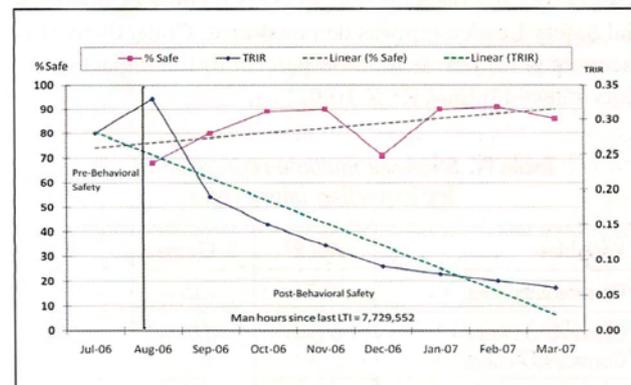
**Injury Results**

The longest straight run without a Lost-time incident was 121 million man-hours. The overall sites incident rates per 200,000 hours worked are quite remarkable, especially given the ramping up of manpower during the project, which traditionally is a time for increased incident rates in the construction industry.

**Table II. Total Recordable Incident Rates (TRIR) by year**

Year of Project	Total Recordable Incident Rate (TRIR) per 200,000hrs worked	Man-hours Worked
Year 1 (2006)	0.09	41,826,852
Year 2 (2007)	0.18	76,369,295
Year 3 (2008)	0.11	120,860,975

This can be seen more clearly in the graph below for one part of the project (Common Offplots), where manpower increased in the time period shown (9 months) from 1600 workers to over 4500 personnel.



**Figure 3. Behavioral improvement and incident reduction trends**

**Multiple Regression Analyses**

Observed percent safe was the dependent variable with senior, middle and Front-line management Safety Leadership treated as independent variables, along with the Corrective Action Rate, observers Visible Ongoing Support records and the Observation Rate (observations expected Vs. completed).

Shown in Table III, the adjusted R<sup>2</sup> results indicate the Corrective Action Rate impacted safety behavior by around 21.5%. Observer VOS records account for a further 32.4% improvement. Adding Front-Line Managers Safety Leadership into the equation accounted for

an additional 19.5% improvement. Middle and Senior managers Safety Leadership accounted for a further 6.7% and 5.5% respectively. Overall, the Corrective Action Rate and managerial Safety Leadership impacted employees' safety behavior, by some 85.6 percent (adjusted  $R^2 \times 100$ ).

**Table III. Stepwise multiple-regression results for impacting safety behavior**

Variables	Adj R <sup>2</sup>	% Change	P<
Corrective Actions	0.215	+21.5%	.01
Corrective Actions + VOS	0.539	+32.4%	.001
Corrective Actions + VOS +FLM	0.734	+19.5%	.001
Corrective Actions + VOS +FLM + MM	0.801	+6.7%	.01
<b>Corrective Actions + VOS +FLM+ MM + SnrM</b>	<b>0.856</b>	<b>+5.5%</b>	<b>.01</b>

Similarly, when the TRIR was entered as the dependent variable, the importance of the Observation Rate, Corrective Action Rate, and workers records of managerial Safety Leadership was demonstrated. Collectively they accounted for between 35-38 percent of the impact on injury rates (adjusted  $R^2 \times 100$ ).

**Table IV. Stepwise multiple-regression results for impacting injury rates**

Variables	Adj R <sup>2</sup>	% Change	P
Observation Rate	0.35	+35%	.01
Observation Rate + Corrective Actions	0.346	-0.04%	.05
<b>Observation Rate + Corrective Actions + VOS</b>	<b>0.378</b>	<b>+3.2%</b>	<b>.01</b>

## Discussion

This study provides compelling evidence regarding the impact that management Safety Leadership exerts on employee safety behavior. This supports Zohar's (23) findings that increasing the frequency of management -subordinate safety interactions positively influences safety performance. The study results also show that in construction it is front-line management that has the most influence. Which managerial level exerts the most influence on employee safety behavior is a significant factor not yet fully explored (24). It has been hypothesized that senior managers influence the behaviors of middle managers, who in turn influence the behaviors of front-line managers, who subsequently influence employee behavior (24). The results reported here support this proposition, as managerial influence appears to increase with closer proximity to the workforce.

The Corrective Action Rate is also a proxy measure of managerial Safety Leadership, as it is they who control

the resources for these to be attended to. This, in conjunction with observer records of the amount of Safety Leadership demonstrated was linked to both behavioral improvement and incident rates. In practical terms, this means attending to any Corrective Actions reported and reinforcing the perception of demonstrable Safety Leadership with the workforce are very important to improve safety performance.

Other practical lessons learnt from this project mirror those from many other projects across all industries (25).

- Employees should observe daily (can take time to get - needs constant attention)
- Corrective actions must be fixed quickly (within 30 days)
- Senior, Middle & Front-line Management Safety Leadership Support is vital
- Dedicated project coordinators are vital to keep project on track
- Monitor B-BS statistics rigorously to keep project on track
- Maintain a consistency of focus, purpose and execution

According to the International Association of Oil & Gas Producers' (OGP) reports in 2007 & 2008 this company was the safest upstream facility in the world for two years running. Such results are an 'independent' indicator of the impact that can be exerted by a well designed and run Behavioral Safety process.

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