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Choosing an Intervention for Implementing Behavior-Based Safety (BBS) in a Building Construction Project

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ABSTRACT
The value of construction works in the country has increased over the last five years, as has the frequency of workplace accidents, which increases the consideration of safety issues in the industry, including the listed private construction firm. Over the last three years, its revenue growth has been countered by a decline in the total number of workplace accidents, notwithstanding an increase in the number of significant workplace accidents. Subcontractors were engaged in around 75% of the company's workplace accidents, with Unsafe Behaviour accounting for more than 60% of the fundamental causes and Unsafe Action accounting for 68% of workplace accidents in 2019. It provides a significant motivation to begin implementing Behaviour Based Safety using the DO-IT (Define-Observe-Intervene-Test) strategy, including in-depth interviews, systematic self-assessment questionnaires, and statistical tests. The findings deal with Safety Key Behaviour (SKB) criteria in 17 areas of the complete construction activity by developing at-risk behaviour that leads to unsafe action by the workers, classified into three circles of processes: execution, supervision, and planning/management. This study will also contribute to discussing reciprocal obligations between companies and subcontractors in prioritizing safety behaviour improvement to assist policymakers in improving safety performance in the sector. It will enable the company and subcontractors to focus on developing and deepening the workers' SKB according to the absolute priority, efficiently and effectively. In the end, it will significantly reduce the accident rate and increasing their reputation as well as their competitive advantage in the construction industry.

Keywords: *Behaviour Based Safety, Safety Key Behaviour, Unsafe Action, At-risk behaviour, Statistics*

1. INTRODUCTION

The construction works value by all construction companies in Indonesia was increased continuously, from Rp. 745.5 Trillion in 2015 to Rp. 1,271.8 Trillion in 2018. As an impact in Macro level, unfortunately, the workplace accident statistic also increased from 105,182 occurrences in 2014 to 138,969 in 2018. Both are shown in Figure1 and Figure 2.

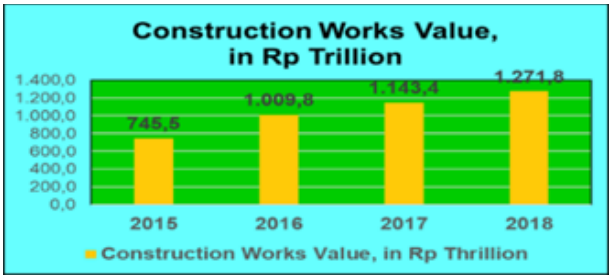


Figure 1 Construction works value (2015-2018)

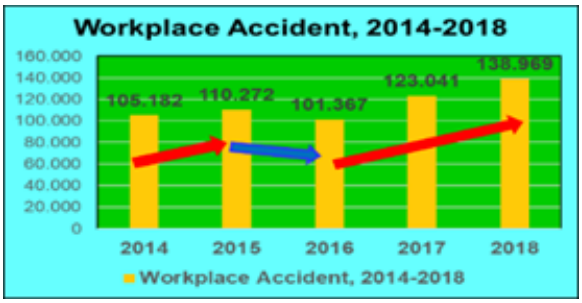


Figure 2 Workplace accident.

Particularly in the construction sector, the accident number portion is 31.9% of an overall workplace accident in 2018 (Figure 3). The trend of industry growth was also enjoyed by the company, which record its revenue from 1.357 billion in 2015 to 3.947 billion in 2019 (Figure 4), by extending work from foundation & building into infrastructure (elevated toll road). Although it is good news that in contrary with the increased national accident number record, the companies were

decreased (Figure 5), but the three major safety performance is worsening in the last 3 years: Fatality, lost Time Injury (LTI) and Medical Treatment Case (MTC). The rests were relatively stable and/or in a positive trend (Figure 6).

Figure 3 Accident in construction.

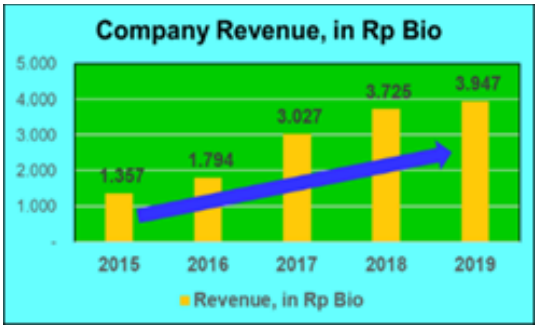


Figure 4 Company Revenue (2015-2019)

Figure 5 Total Accident (2017-2019)

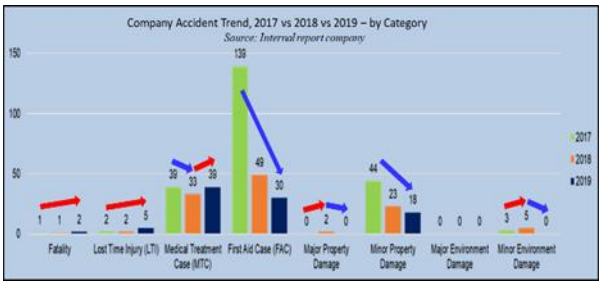


Figure 6 Company accident trend (2017-2019)

The internal investigation within the company reported the exact accident root causes in 2018 and 2019, as shown in Figure 7. It revealed the major root causes according to two factors. On the Personal factor, Lack of Knowledge and Improper Motivation jointly shared 62% (93 of 151). While on the Job factor, Inadequate Leadership/Supervision and Inadequate SOP (Standard Operation Procedure) for Work jointly shared 61% (112 of 183) of causes.

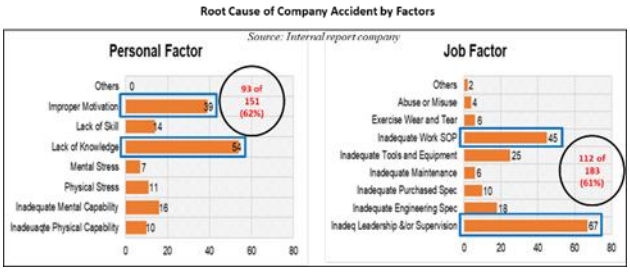


Figure 7 Root causes of company accident by factors (2018-2019)

Figure 8 tells the 2019 monthly accident downtrend of total accident record 94; it started by 13 in January, ended by 3 in December. Figure 9 show Unsafe Action shared majority by 64 (68%) portions on the direct cause. Some of the challenge due to the nature in the industry is, high turnover of workers, discipline and manipulative of presence. The face recognition of the security system may help from the attendance system [1]. It all tells that workers' behaviour was the main reason behind the accident causes, driven by unsafe action; and calls the urgency to determine the priority to improve worker's safety behaviour.

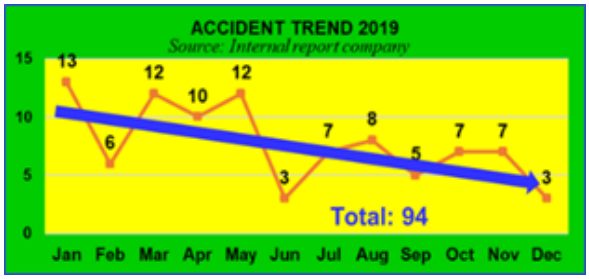


Figure 8 Monthly accident trend

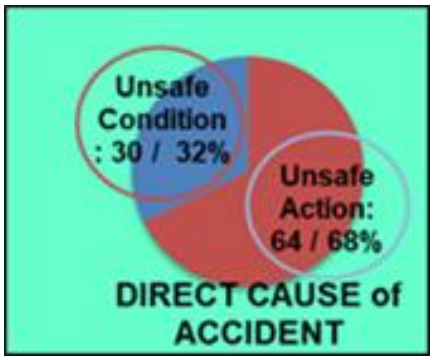


Figure 9 Accident causes

2. LITERATURE REVIEW

2.1. Theoretical Perspective

Heinrich's domino theory (by H.W. Heinrich in 1931), using the analogy of the domino model concluding the idea that human plays the most critical role in the occurrence of an accident. According to him, five interlinked factors may cause accidents in a sequence of failure illustrated as five standing-domino cards, each representing: Social Environment & Ancestry, Fault of Person, Unsafe Act or Condition, Accident and Injury (Figure 10). If the 1st card falls, it will fall on the next until all cards fall together. The key to preventing accidents is eliminating the 3rd of the five factors, which is Unsafe Action/Condition [2]. Similar to what shown in Figure 9, Unsafe Action was the leading cause of the accident, rather than Unsafe Condition. This leads to the focus on safety behaviour that drives the unsafe action.

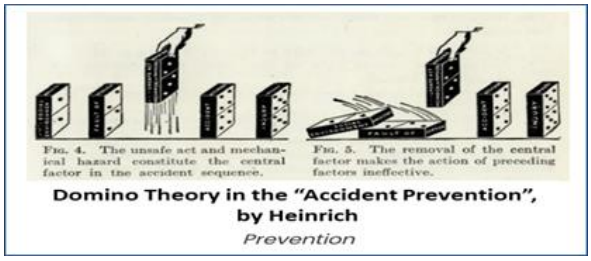


Figure 10 Domino theory in the "Accident Prevention"

2.2. Previous Studies

The initial behaviour-based safety (BBS) management technique was introduced in a carefully controlled seven public-housing construction sites in Hong Kong, covered performance measurement and feedback and participative goal setting. The BBS categories covered in this survey were: housekeeping, access to height, PPE and (use of bamboo) scaffolding [3].

Table 1. Safety research comparison in construction industry

No.	Author	Methods			Approach		Performance Indicator(s)		Location(s)
		In-dept interview	Structured Questionaire	Statistics	DO IT	Other(s)	Safety Index	Other(s)	
1	Lingard & Rowlinson (1997)		X	X	Partial		Partial		Hong Kong
2	Chen & Tian (2012)		X	X	X		X		China
3	Choudhry (2014)		X	X	Partial			Safety Performance	Hong Kong
4	Guo et al.(2018)	X		X	Partial	System Dynamic		Unsafe Behavior	Singapore
5	Proposed Paper		X	X	X	Circle of Processes		Safety Key Behavior and Unsafe Action	Indonesia

To improve unsafe human behaviour and prevent an accident, BBS is commonly believed as the most effective method, since it can provide one structural and quantitative approach for safety management and safety in any production process in long term mechanism by measuring and improving thru some methods, such as observation, analysis and feedback.

Table 2. Safety key behavior (SKB) comparison

	No	Code	Author(s) / SKB criteria	Lingard & Rowlinson (1997)	Chen & Tian (2012)	Choudhry (2014)	Guo et al. (2018)	Proposed Paper
Safety Key Behaviour (SKB) Criteria	1	a	PPE	X		X	X	X
	2	b	Housekeeping	X		X		X
	3	c	Accss to, and/or work at, height	X		X	X	X
	4	d	Plant and equipment			X	X	X
	5	e	Scaffolding and formwork	X		X	X	X
	6	f	Lifting operation				X	X
	7	g	Excavation				X	X
	8	h	Manual handling				X	X
	9	i	Hot work				X	X
	10	j	Traffic management				X	X
	11	k	Temporary electricity					X
	12	l	Site environment management					X
	13	m	Device management					X
	14	n	Dangerous goods					X
	15	o	Protection for holes/edges					X
	16	p	Unsafe behavior					X
	17	q	Values/motivation					X

Abbreviations: PPE = Personal Protective Equipment

Table 3. Behavior based safety element comparison

No.	Author	Methods						Industrial Adaptability
		Baseline Observation	Goal Setting	Follow-up Observation	Feed Back	Training	Reward & punishment	
1	Lingard & Rowlinson (1997)	X	X		X			++
2	Chen & Tian (2012)	X	X			X		+
3	Choudhry (2014)	X	X		X			++
4	Guo et al.(2018)	X	X		X	X	X	+++
5	Proposed Paper	X	X	X	X	X	X	+++

Legends : + Low adaptability ++ Moderate adaptability +++ High adaptability

The best way to define unsafe behaviour is to ask the employee itself and the employee's participation, through DO IT sustainable improvement process approach in changing critical behaviour, introduced by Geller, which stands for D=Define, O=Observe, I=Intervene to improve behaviour, T=Test impact of intervention [4]. This approach will be adopted in this research study. Another method is using the BBS research phases, which consists of four phases: 1) preliminary study; 2) data collection; 3) data analysis phase; and 4) reporting [5]. The other research conducted was a BBS program implementation in the MRT tunnel project in the Singapore construction industry, intending to reduce unsafe behaviour categorized in 9 areas [6], detailed in Table 2. From both tables of the literature review matrix, the critical takeaway is put into a mind-map to identify the gap and potential novelty, as illustrated in Figure 11.

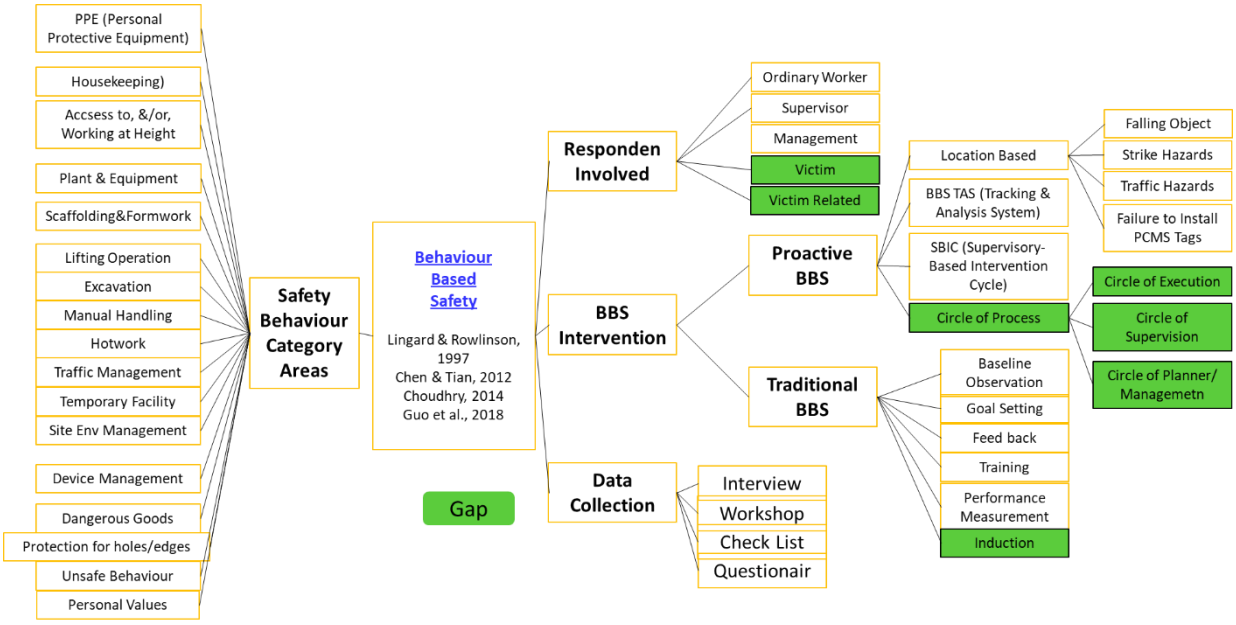


Figure 1. Mind-map gap of literature review

The respondent involved in previous research usually gets along with ordinary workers, supervisors, and management people. From the pro-active BBS intervention approach, this research will see from the perspective of processes divided into three circles: Execution, Supervision and Planning or Management point of view. Besides, this study will also be using the Safety Behaviour criteria or BBS category, which combined from several of that research, resulting in 17 category areas (a to q) as shown in Figure12.

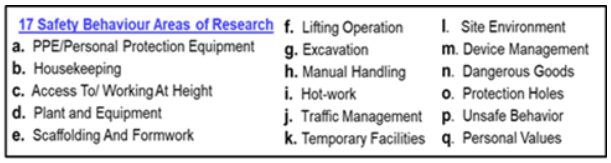


Figure 2 The 17 safety behavior areas of research

3. METHODS

The general method of this research consist of six main steps. The first three are following the D+O sustainable improvement process and the available research phases accordingly. The 4th step is analysis and review, consisting of statistical tests: validity, reliability, normality and box plotting for each circle of processes: Execution, Supervision and Planning/Management. The 5th is discussing the analysis result to conclude the significant finding, action required and recommendation. The last one, this study is expected to produce separate output and trigger beneficial outcomes (Figure13). The overall analysis method is adopting the DO IT approach, which stands for Define-Observe-Intervene (and supposed to continue with: Test), as well as detail ordinary research phases, starting from Preliminary Study, Data Collection, Data Analysis and Reporting [5], as illustrated in Figure14.

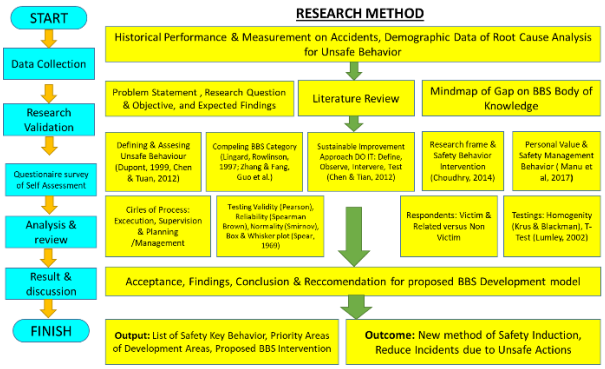


Figure 3. Research framework

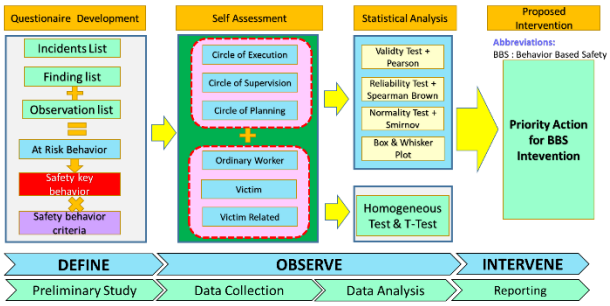


Figure 4. Analytical method

3.1. Define (Preliminary Study)

To conduct D (Define) in this case study, a preliminary survey of defining unsafe behaviour and identifying dangerous action is proposed to get a basic understanding. It compiled overall findings from three sources within the company initiatives. First, company Finding List in period Jan'2019-Jun'20, consists of three

reports, i.e.: Monthly Site Risk Assessment (SRA) list which got 494 findings, Daily Inspection Report (DIR) list which got 1.284 findings, and Green Card Report (GCR) list which got 1.064 findings. Second, findings of historical Incidents List recorded in the year 2018-June 2020, was 82 cases in detail. Third, finding under ad-hoc Observation List, conducted in Sept'20 when Safety Management Leaders were visiting a designated project for the BBS initiative, resulting 48 findings.

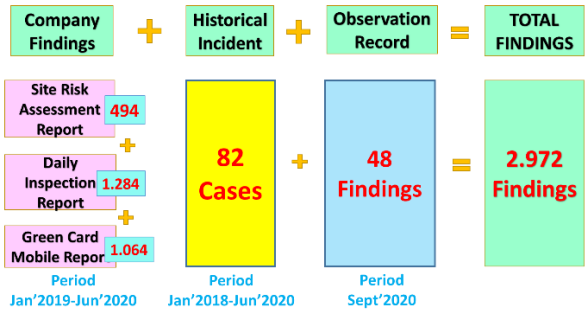


Figure 5. Scheme of DEFINE step

The sum of all findings from those three sources is a total of 2.972 items (Figure 15). Among those list of findings, the similar symptom & occurrence is combined and united to be simplified to define the Summary of Unsafe Action called At-risk Behavior Summary, which is divided into three groups according to processes in construction: Circle o f Execution (CoE), consists of all at-risk behaviour found in the history and listed during the execution of activities by the workers on-site/project, which all of them belong to the subcontractors; Circle of Supervision (CoS), based on findings during the supervision activities by the Supervisor on site/project, combined from the subcontractors' and the company's; Circle of Planning/ Management (CoP/M), based on findings during the planning and/or management levels that all of them belongs to the company. The summary of At-risk Behavior is 67 items in CoE, 68 items in CoS, and 70 items in CoP/M.

Table 4. Summary at-risk behavior circle of execution

SAFETY KEY BEHAVIOR FORMULATION Circle of Execution			
No.	**At Risk Behaviour**	**Safety Behaviour Categories Areas of Research**	**Urgency**
1	Worker does NOT wear mandatory PPE in complete and proper manner	PPE	Frequent Risk
2	Worker does NOT wear Full Body Hamess when working at height	PPE	Frequent Risk
3	Worker put material or waste at the accsess/perimeter	Housekeeping	Frequent Risk
4	Worker does NOT clean/tidy up messy material/tools after finish working	Housekeeping	Frequent Risk
5	Worker let the electricity cable in a mess/on the floor/lay on the conductor	Temporary Electricity	Frequent Risk
6	Worker does NOT put the hazardeous material/waste in the designated bin for it (TPS B3/LB3)	Site Env. Management	Frequent Risk
7	Worker does NOT wear spesial PPE according to its particular type of work	PPE	Frequent Risk
8	Worker uses machinery without protection and/or hand grip	Plant & Equipment	Frequent Risk
9	Worker does NOT wear gloves/apron/mask when perform welding job	Hot work	Frequent Risk
10	Worker does NOT hook the Full Body Harness when working and/or moving at height	PPE	Frequent Risk
11	Worker uses non-standard scaffolding	Scaffolding & Formwork	Frequent Risk
12	Worker does NOT wear mask/glasses/faceshield when performing cutting/grinding job	Hot work	Frequent Risk
13	Worker uses untagged/uninspected tools/working machinery	Plant & Equipment	Frequent Risk

14	Worker does NOT take care/keep in a save place of the tools/materials after working	Housekeeping	Frequent Risk
15	Worker uses unspec rope to tie cable/hose of oxygen tube/protection bar/pipes	Temporary Electricity	Frequent Risk
16	Worker throw waste material to improper place	Unsafe Behaviour	Frequent Risk
17	Worker smokes out of the designated areas	Unsafe Behaviour	Frequent Risk
18	Worker perform hot work job beyond required SOP (Standar Operating Procedure)	Hot work	Frequent Risk
19	Worker uses acetylene tube without flashback arrestor	Hot work	Frequent Risk
20	Worker uses improper/unspec base/platform for working	Scaffolding & Formwork	Frequent Risk
21	Worker uses non-standard electricity socket	Temporary Electricity	Frequent Risk
22	Worker uses Full Body Harness with single lanyard when working at height	PPE	High Risk
23	Worker uses improper accsess or does NOT use the available designated access	Scaffolding & Formwork	High Risk
24	Worker does NOT use tagline to help directing when lift something	Lifting Operation	High Risk
25	Worker enter dangerous zone (dark, slippery, many holes and unsecure goods) without permission	Unsafe Behaviour	High Risk
26	Worker does NOT use Self Contain Breathing Apparatus (SCBA) when working in confine space	PPE	High Risk
27	Worker does NOT uses life jacket when working close to/at the deep water area	PPE	High Risk
28	Worker take a rest in the unsafe area/places	Unsafe Behaviour	High Risk
29	Worker stands/performing works under the area of lifting	Lifting Operation	High Risk
30	Worker trespass barricade of the lifting area or heavy equipment working area	Unsafe Behaviour	High Risk
31	Worker stand within swing radius area of machine's under operation	Unsafe Behaviour	High Risk
32	Workers does NOT apply lifeline when working at height	Access to, and/or Work at Height	High Risk
33	Worker uses LPG tube for hotwork	Hot work	High Risk
34	Operator does NOT give any command/signal when machine is moving	Plant & Equipment	High Risk
35	Operator does NOT turn off machinery after finish operating it	Plant & Equipment	High Risk
36	Worker ignore warning when does NOT wear proper PPE	PPE	High Risk
37	Flagman perform other job (multitasking) when arranging machine's movement	Unsafe Behaviour	Accident Caused
38	Worker performs scaffolding dismantle without nay clear working instruction	Scaffolding & Formwork	Accident Caused

39	Worker take F&B from operator using pipe from lift crane platform onto the Passenger Hoise roof	Access to, and/or Work at Height	Accident Caused
40	Worker lay-down railing at the void area to move waste material	Access to, and/or Work at Height	Accident Caused
41	Worker move on scaffolding up & down without applying three-point of contact	Scaffolding & Formwork	Accident Caused
42	Operator does NOT perform pre-inspection equipment before properly operate it	Plant & Equipment	Accident Caused
43	Worker does NOT use proper supporting device for work	Plant & Equipment	Accident Caused
44	Worker keep continuing job when it is raining	Unsafe Behaviour	Accident Caused
45	Worker release securing bolt on the working device	Plant & Equipment	Accident Caused
46	Worker set crossbrace untightly	Scaffolding & Formwork	Accident Caused
47	Worker does NOT apply correct tied when perform lifting	Lifting Operation	Accident Caused
48	Did the unsafe/improper lifting process	Lifting Operation	Accident Caused
49	Worker perform manual lifting beyond correct procedure	Manual Handling	Accident Caused
50	Worker does NOT use proper gloves when working on a sharp tool/material	PPE	Accident Caused
51	Worker put on galvanize pipe on formwork which gonna be dismantled	Unsafe Behaviour	Accident Caused
52	Worker perform a job with still improperly/insecurely	Unsafe Behaviour	Accident Caused
53	Worker rush-in to enter the passenger hoist	Unsafe Behaviour	Accident Caused
54	Worker perform cutting job exceed the cutting limit	Plant & Equipment	Accident Caused
55	Worker uses working device beyonds its common usage	Plant & Equipment	Accident Caused
56	Worker does NOT operate truck/machinery correctly and/or carefully	Unsafe Behaviour	Accident Caused
57	Worker moves device/material unsafely/unsecurely	Plant & Equipment	Accident Caused
58	Worker modifies working device so that make it unsafe to be used	Plant & Equipment	Accident Caused
59	Worker does NOT uses glasses and/or earplug when performing destroying wall (pembobokan)	PPE	Accident Caused
60	Finger position was on the nip/pinch point of working machine.	Unsafe Behaviour	Accident Caused
61	Worker misoperate the strand jack	Plant & Equipment	Accident Caused

62	Operator operate machine in a fatigue condition	Unsafe Behaviour	Accident Caused
63	Workers does NOT apply lock button on the manlift panel	Plant & Equipment	Accident Caused
64	Worker operates bending machine withour authorization	Plant & Equipment	Accident Caused
65	Worker disobey his leg which hurt by concrete cement	Unsafe Behaviour	Accident Caused
66	Worker open the radiator plug when the machine is still hot	Hot work	Accident Caused
67	Worker does NOT remove gas tube and strecth hose in a proper tension when perform cutting with welding machine	Hot work	Accident Caused

Those At-risk Behavior summaries are divided into 17 categories of Safety Behavior, noted from a to q (Figure 12), which will become the research questionnaire areas. Then later, each of them will be converted in contrary into Safety Key Behavior (SKB) list, the recommended positive behaviour as a safety action of each list. The example of its complete list of At-risk Behavior Summary in CoE is in Table 4.

3.2. Observe (Data Collection + Data Analysis)

Based on the SKB Summary, the O (Observe) is started by developing a Self-Assessment Questionnaire for a quantitative survey, which uses DuPont Bradley Curve scoring, consists of 4 scales in safety behaviour: (1) Reactive; (2) Dependent; (3) Independent; and (4) Interdependent. The company target scale of employee behaviour is 3 (independent), as the pilot BBS development. There is 79 Questionnaire for workers in CoE, 68 Questionnaires for Supervisors in CoS and 70 Questionnaires for employees in CoP/M. The typical form of Questionnaires for each circle is the same, and each consists of three-part: Part-1 Introduction; Part-2 Respondents Identity; Part 3 Body of Questionnaires.

17 Subcontractors supported the designated project, and no Mandor (Labour Suppliers) employs around 364 to 479 staff and workers. To determine the sample size of the population for a survey, it applied the Harry King Nomogram for the workers belong to CoE, which at the week of a study conducted, 387 workers were registered, so with a significance level of 7.5%, it concluded the minimum sample of the population is 25% (97 of 387 at minimum get 101 respondents). Each subcontractor should contribute workers proportionally to sum up, the minimum target.

Differently, for both of the CoS & CoP/M groups, the study targeted 100% respondents; so, it got 41 (24 from the subcontractors' and 17 from the company's) and 22 (of the company's planner/staff/managers only) respectively, as appointed and agreed by (and including) the Project Manager. The respondent summary is presented in Table 5.

Table 5. Respondent summary

No	Description	C o E	C o S	C o P/M
1	At-risk Behavior	67	68	70
2	Questions	79	68	48
3	Respondents	101	41	22
4	Victim Related	6	10	7
5	Non-Victim Related	95	31	15

The following step is statistical analysis, starting with the Pearson analysis correlation test to get the validity of the questionnaire survey results. Based on the valid items, the reliability test was carried out according to the Spearman-Brown coefficient. If the r-stat number < Spearman Formula number (with the significance level of 5%), it is categorized as reliable.

Furthermore, the Smirnov normality test was carried out to determine the data distribution. If the result obtained that D-max number <D-critical number, it means that the distribution is normal.

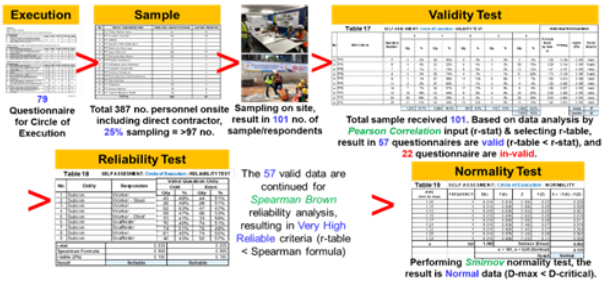


Figure 6 Statistical analysis for circle of execution

The sequence of these statistical analyses is illustrated in Figure16, using CoE as the example. At the same time, the overall statistical analysis result of those complete three circles can be summarized below in Table 6.

Table 6. Summary of statistical analysis.

Description		CoE	CoS	CoP/M
No. of Respondents		101	41	22
No. of Questions		79	68	70
Valid Questions		57	67	66
Reliability Test	r-stat	0,939	0,962	0,986
	S/B formula	0,969	0,981	0,993
	r-table (5%)	0,195	0,308	0,482
	Result	High Reliable	High Reliable	High Reliable
Normality Test	Dmax	0,082	0,21	0,21
	Dcritical	0,135	0,297	0,297
	Result	Normal	Normal	Normal

S/B: Spearman Brown CoS: Circle of Supervision
CoE: Circle of Execution CoP/M: Circle of Planning/Management

3.3. Intervene (Reporting)

The subsequent process under the DO-IT approach is called Intervene (to improve the behaviour). Based on the statistical analysis result, the data skewness distribution is visualized using Box and Whisker Plot (BWP or boxplot) analysis to visually graph the result data through the quartiles (Figure 17).

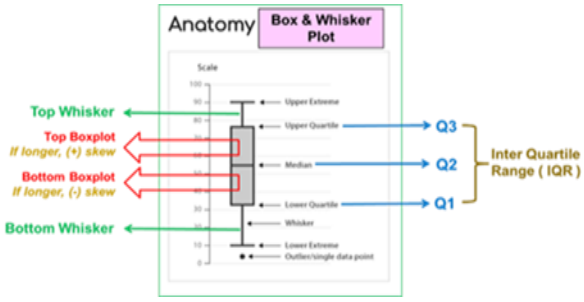


Figure 7 Anatomy of box and Whiskers plot (boxplot)

It is expected to get series of output numbers and figures that can lead the analysis into essential findings and/or directing into some level of priority to action to determine the focus to intervene Safety Behavior initiative. The proposed intervention will be derived for each circle of the process. The rest of the interfering activities, e.g., feedback, training, performance measures and safety induction method (the new approach), also the T (Test) activity, are out of this scope due to the time and schedule limitation.

4. RESULT AND DISCUSSION

4.1. Circle of Execution (CoE)

There are 12 valid data out of 17 SKB criteria. The BWP figure can be divided into three groups of categories, which are: first, called Main Priority group, all or almost all Inter-Quartile Range (IQR) data is majority below score 2, i.e. (refer to Figure 12.): a), b), c), e), f), and p).

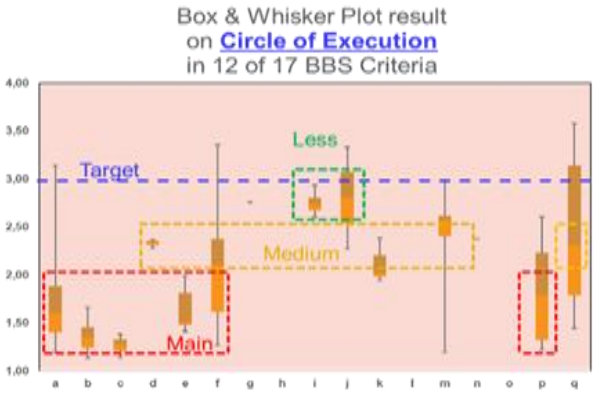


Figure 8 Boxplot of circle of execution

The second group, called Medium Priority, i.e., d), k), m), and q) which most of the IQR is majority score around 2.0-2.5. The last group, Less Priority for intervention, consists of i) and j), which is their IQR above 2.5 up to almost/over 3.

4.2. Circle of Supervision (CoS)

Differently, the CoS's data survey results in quite a clear boxplot which is all valid data scores below 2, even few of them started from 1. The accurate data survey consists of 11 out of 17 SKB criteria, i.e., a), d), e), f), g), h), i), j), k), m), and q). Among those 11 SKB criteria, only 3 of them whose top whiskers are around and above 2.5, but compared to the total sample of its boxplot's data, it can be considerably ignored.

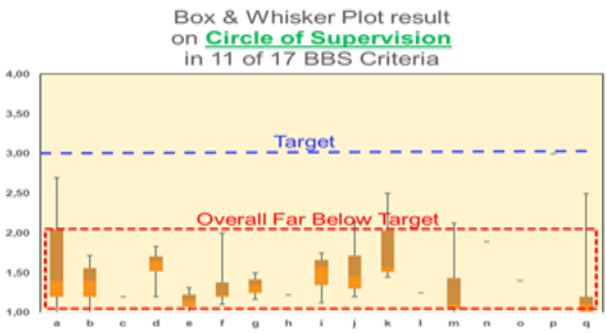


Figure 9 Boxplot of circle of supervision

4.3. Circle of Planning/Management (CoP/M)

Similarly, the CoP/M's data skewness also results in 11 boxplots out of 17 SKB criteria with spreading figures. It shows that 8 of 11 boxplots are scoring on and/or below 2, but all of their bottom boxplots start from a score of 1.5. These are: b), c), d), e), h), m), o), and p). The other 2: f) and q) in which their Q1 and Q2 are similarly below 2, with only their Q3 are between 2.0 and 2.5, and also their top whiskers are over 3. Due to the majority boxplot's nature below 2, these 8+2 SKB criteria are considered Main Priority. Another one, k) which its boxplot is above, but close to, score two could be regarded as Medium Priority.

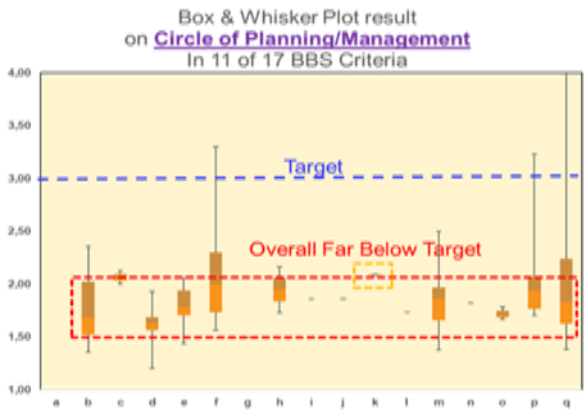


Figure 10 Boxplot of circle of planning/management

Table 7. Summary of SKB score level and priority

No	Subject		C o E	C o S	C o P/M
1	No. of Respondents		101	41	23
2	No. of Total Questionnaire		79	68	70
3	No. of Valid Questionnaire		57	67	66
4	Areas of 17x BBS Criteria:		12	11	11
	PPE/Personal Protection Equipment	a	1	1	
	Housekeeping	b	1	1	1
	Acces To/ Working At Height	c	1		1
	Plant and Equipment	d	1	1	1
	Scaffolding And Formwork	e	1	1	1
	Lifting Operation	f	1	1	1
	Excavation	g		1	
Red: < 2.0	Manual Handling	h			1
	Hotwork	i	1	1	
Brown: 2 - 2.5	Traffic Management	j	1	1	
	Temporary Facilities	k	1	1	1
Green: 2.5 - 3.0	Site Environment	l			
	Device Management	m	1	1	1
	Dangerous Goods	n			
	Protection Holes	o			1
	Unsafe Behavior	p	1		1
	Personal Values	q	1	1	1
5	Validity - Pearson Correlation		Valid	Valid	Valid
6	Reliability - Spearman Brown		High Reliable	High Reliable	High Reliable
7	Normality - Smirnov		Normal	Normal	Normal

Table 7 summarize the score details of SKB criteria and Priority category (by colour) on each Circle of the Process.

5. CONCLUSION & RECOMMENDATION

5.1. Conclusion

Among the circle of processes, Figure 21 conclude as follows:

1) Supervisors are the ones who need most of the education on SKB areas since they are most REACTIVE (closer to 1 instead of 2). Management/Planners has better SKB awareness than Supervisors, although both are still DEPENDENT (average scores around 2). Workers' average is slightly above the other two, but still close to 2.

2) So, all three of them are below the company target score of SKB level at 3 (INDEPENDENT).

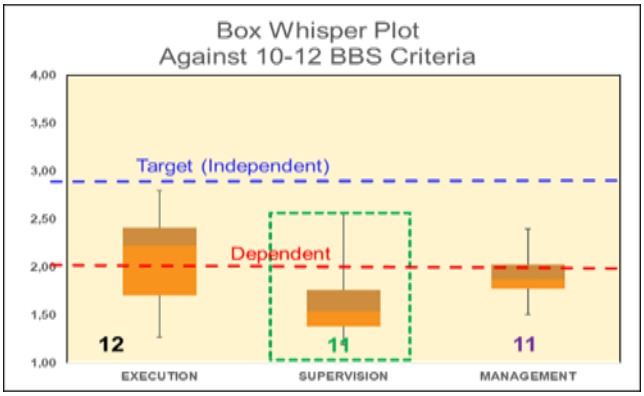


Figure 11 Safety behaviour level of each circle of process

From 17 SKB areas, the valid data results in each circle are: 12x for CoE, 11 for CoS and 11 for CoP/M. The detailed priority of SKB intervention among them is presented in Table 8.

1) Main priority, represented in Table 8, by red-boxes:

a) CoE: a) PPE, b) Housekeeping, c) Access to working height, e) Scaffolding and or formwork, f) Lifting operation, and p) Unsafe Behavior.

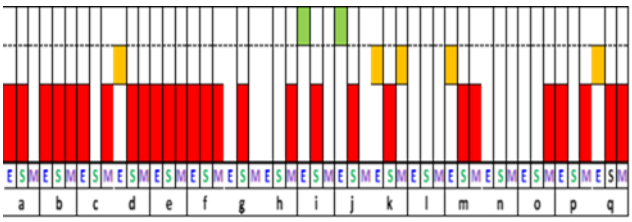
b) CoS: a) PPE/Personal Protection Equipment; b) Housekeeping; d) Plant and Equipment; e) Scaffolding and Formwork; f) Lifting Operation; g) Excavation; i) Hot-work; j) Traffic Management; k) Temporary Facilities; m) Device Management; and q) Personal Values.

c) CoP/M: b) Housekeeping; c) Access To/Working at Height; d) Plant and Equipment; e) Scaffolding and Formwork; f) Lifting Operation; h) Manual Handling; k) Temporary Facilities; m) Device Management; o) Protection Holes; p) Unsafe Behavior; q) Personal Values, since most of them are still independent mode (score 1.5 to 2.0), with one exception form) Device Management could be considered a medium priority.

2) Medium Priority, represented by brown-boxes, is only in the CoE group, i.e., Plant and equipment, Temporary facilities, Device management, Personal values); plus m) Device management of CoP/M.

3) Less Priority, represented by green-boxes, is only in the CoE group, i.e., i) Hot work and j) Traffic management.

Table 8. Priority intervention on each SKB across circles



5.2. Recommendation

1) Completing the research sequence of the DO IT approach by performing the T (Testing) in this project.

2) Conducting similar research to the company's other construction works, i.e., infrastructure, foundation and soil improvement.

3) Regardless of the intervention priority based on the SKB criteria, the company should develop a more comprehensive pre-working Safety Induction method for employees by audiovisual of any sample on unsafe actions and impacts.

AUTHORS' CONTRIBUTIONS

Yohanes Eka Prayuda made contributions as first authors. Data was collected and analysed by Yohanes Eka Prayuda and Sumarsono Sudarto. All authors (Edi Sofyan, Gembong Baskoro, Aditya Tirta Pratama, and Henry Nasution) made contributions to the design of the study and the writing of the manuscript.

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