Safety Compliance of the Construction Workers in Hong Kong: An Application of the Theory of Planned Behaviour using Sociotechnical Systems Approach

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Abstract

Despite there are numerous studies on accident causation, the improvement of construction safety seems at a standstill. Recent studies advocate the concept of "socio-technical system" which recognises the complexity of construction safety. Within the socio-technical system, "human" is one of the keys to accidents, and the construction workers are the victims of accidents. However, there is no well-established theoretical framework for understanding the safety compliance of construction workers. This paper aims to examine the safety compliance of the construction workers in the Hong Kong construction industry. Safety compliance model was developed by operationalising Theory of Planned Behaviour in Hong Kong construction industry. A questionnaire was administrated for measuring the proximal and distal factors affecting safety compliance and self-reported safety compliance level among Hong Kong construction workers. A total of three hundred sixty-five valid responses obtained from two large contractors used for analysis. The results suggest that Hong Kong construction workers' intention is positively linked to safety compliance. Two proximal factors are perceived behavioural control and attitude. These proximal factors significantly affect the workers' intention. Whereas, a high-reliability organising contributes two proximal factors and descriptive norms.

The findings highlight the importance of interventions for improving the workers' intention of safety compliance. Construction organisations also need to advocate the need for high-reliability organising. The study further shed light on safety engagement as the next step for safety management in the Hong Kong construction industry.

Keywords: Safety compliance, Theory of Planned Behaviour, High-reliability organising, Engagement

1. Introduction

Despite there are numerous studies on accident causation, the improvement of construction safety seems at a standstill. In 2016, the Hong Kong construction industry accidents and the accident rate per 1,000 construction workers decreased by 0.1 percent and 11.8 percent respectively than 2015. However, the construction industry still recorded the highest number of fatalities and accidents among all industry sectors in Hong Kong (Labour Department, 2017).

Since the "lesson-learn" approach cannot be tolerated for tragedies, safety assessment has shifted from lagging measures based on retrospective data to leading or predictive assessment of safety climate – "a snapshot of the state of safety providing an indicator of the underlying safety culture of a work group, plant or organisation" (Flin et al., 2000, p. 178). Advocated by many recent studies, the "socio-technical system" depicts even wider direction of thinking. The sociotechnical system refers to "the interactive influences of social and technological factors in determining the nature of work performed within an organisation and, to a large extent, the "culture" of the organisation itself" (Noy et al., 2015, p. 544). The social sub-system is constituted by a worker's network of work relations whereas the technology sub-system is comprised of technologies, artefacts with the work processes and techniques that shape their use and production (Noy et al., 2015). Despite the continuous development of safety research, there is no well-established theoretical framework for understanding safety compliance of construction workers in Hong Kong.

The aim of this study is to examine safety compliance of the construction workers in Hong Kong and discuss the root causes of the current condition. Previous studies and literature were reviewed for identifying the factors affecting safety compliance. The questionnaire survey was then developed for data collection. The results were analysed and several significant results were found which shed light on the direction of safety management in Hong Kong.

2. Theoretical Framework

2.1 Theory of Planned Behaviour (TPB)

The TPB was originally developed by social psychologists to predict and explain human behaviour in specific contexts (Ajzen, 1991). The theory has been widely adopted for understanding and predicting violations and risk behaviours in many fields of science like medical and education. According to the TPB, intention is the most proximal predictor of human behaviour which "captures the motivational factors that influence a behaviour; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behaviour" (Ajzen, 1991, p. 181). Intention is affected by three cognitive determinants (attitude, perceived behavioural control and norms). Attitude is defined as "positive or negative value of a specific behaviour" (Ajzen, 1991). Perceived behavioural control refers to people's perceived ability to perform behaviour (Ajzen, 2015 and 1991). Apart from self-competence, perceived behavioural control can be regarded as work pressures and reflects external influences, such as lack of resources and time limitation, which are beyond the control of individual workers (Fogarty & Shaw, 2010).

Norms refer to how coworkers and supervisors of the construction workers think about safety (subjective norms) and whether they would engage in the behaviour (descriptive norms). Subjective norms and descriptive norms can be viewed as a meso-level factor. The original TPB only includes subjective norms which refer to "perceived social pressure to engage or not to engage in behaviour" (Ajzen, 2015 and 1991). In recent studies, for example, Fugas, Silva and Meliá (2012) examine the descriptive and injunctive norms of coworkers and supervisors separately.

Despite the TPB has been well examined for explaining human behaviour, Ajzen (2017) admits that there are background factors – individual (e.g. personality, mood, emotion, intelligence, values, stereotypes, experience, etc.), social (e.g. education, age, gender, income, religion, race, ethnicity, culture, laws, etc.) and information (e.g. knowledge, media, intervention, etc.) affecting the three cognitive determinants. For instance, safety attitude of the construction workers interacts with the factors that are more distal. Langford, Rowlinson and Sawacha (2000) suggest that (1) organisational policy; (2) supervision and equipment management; (3) management behaviour; (4) industry norms; (5) attitude to risks taking affect attitude of the construction workers. Therefore, attitude is a micro factor as it is related to personal value but contributed by many other factors. Considering the context of the Hong Kong construction industry and based on the literature review, perceived quality of safety rules and procedures and High Reliability Organising (HRO) are incorporated into the research model.

2.2 Perceived Quality of Safety Rules and Procedures

Violations refer to people not following the rules intentionally (Hudson et al., 1998). The importance of rules in distinguishing violations from other risk behaviours and the roles of rules in affecting the behaviours are pinpointed in Reason (2008) and Lawton (1998) that there are good, bad or even no rules and they are not always applicable well in every context. Cox and Cheyne (2000) suggest that safety level is affected by the extent to which workers perceive safety rules and procedures. Perceived quality of safety rules and procedures measure how the workers think about the safety rules and procedures, i.e. whether the objectives are clear and the applications are appropriate.

2.3 High Reliability Organising (HRO)

HRO refers to the organisation's ability of anticipating and controlling the unexpected safety events (Weick & Sutcliffe, 2007). Among the five principles of HRO, the first three principles, i.e. preoccupation with failure, reluctance to simplify and sensitivity to operations, can be categorised as the principles of anticipation which focuses on the prevention of disruptive unexpected events. However, mindful attention shifts to practices of containment, i.e. commitment to resilience and deference to expertise, when unexpected events continue to develop (Weick & Sutcliffe, 2007). The concept of HRO can be viewed as the organisational, macro-level factor of safety compliance.

3. Research Model

This study discusses the root causes of the current condition from micro to macro levels using the socio-technical system thinking. With the appropriate development of the original TPB to cater for the unique context and the caution for interpreting the findings, it is reasonable to suggest that the TPB to be used as a clear framework of understanding safety compliance of the Hong Kong construction workers. Safety violations and safety participation are also examined in this study. The research model is shown as below figure.

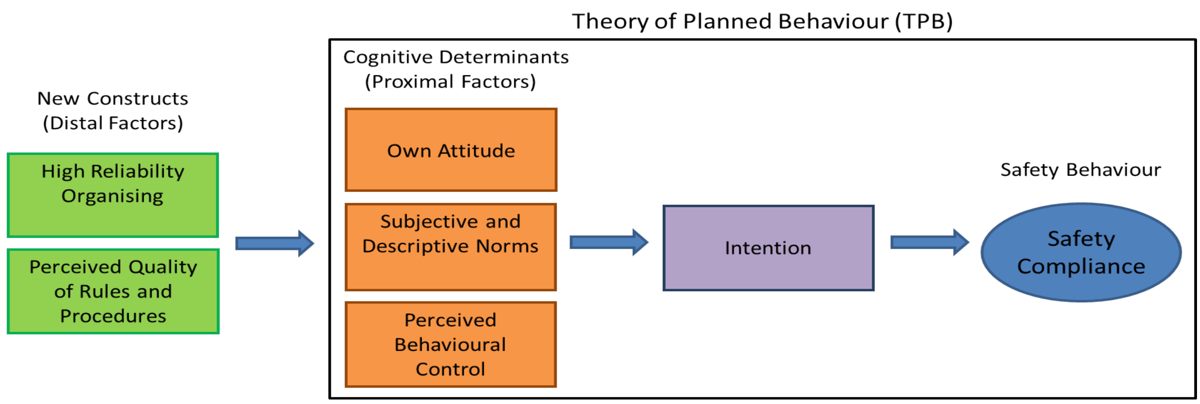

Figure 1: Research Model

According to the TPB, intention is the most proximal predictor of human behaviour (Ajzen, 1991).
Hypothesis 1a (H1a): Intention (of safety violations) has negative impacts on safety compliance.
Hypothesis 1b (H1b): Intention (of safety violations) has positive impacts on safety violations.
Hypothesis 1c (H1c): Intention (of safety violations) has negative impacts on safety participation.
Intention can be affected by three proximal factors (attitude, perceived behavioural control and norms) and two distal factors (perceived quality of safety rules and procedures and HRO).

Attitude refers to how the workers think about safety. When they think that following safety rules and procedures is good and worthwhile, they are more likely to comply with safety rules and procedures, i.e. higher intention to safety compliance. On the contrary, they have higher intention to safety violations if they think that following safety rules and procedures is of negative value.
Hypothesis 2 (H2): Attitude (of safety violations) has positive impacts on intention of safety violations.

Perceived behavioural control measures the workers' perception of their ability and resources available for following safety rules and procedures. Workers do not always have full volitional control on their safety behaviours as there are always interactions among work team, workplace, materials and equipment during construction works (Haslam et al., 2005).
Hypothesis 3 (H3): Perceived behavioural control (of safety violations) has positive impacts on intention of safety violations.

Norms refer to how the workers' coworkers and supervisors think about safety (subjective norms) and whether they would engage in the behaviour (descriptive norms). Based on the research model, the construction workers would have higher intention to safety violations when both their coworkers and supervisors are less determined to safety and they are perceived not always following the safety rules and procedures.
Hypothesis 4 (H4): Norms (of safety violations) has positive impacts on intention of safety violations.

Perceived quality of safety rules and procedures measure how the workers think about safety rules and procedures, i.e. whether the objectives are clear and the applications are appropriate. When construction workers perceive the safety rules and procedures are of high level, they have less positive attitude, norms and perceived behavioural control on safety violations.
Hypothesis 5a (H5a): Perceived quality of safety rules and procedures has positive impacts on attitude of safety compliance.
Hypothesis 5b (H5b): Perceived quality of safety rules and procedures has positive impacts on norms of safety compliance.
Hypothesis 5c (H5c): Perceived quality of safety rules and procedures has positive impacts on perceived behavioural control of safety compliance.

HRO refers to the organisation's ability of anticipating and controlling the unexpected safety events. For construction projects, construction sites are remote from head office. Safety rules and procedures are established by top management in head office whereas site office staff implement safety rules and procedures and to be followed by workers. The construction workers would have more positive attitude, norms and perceived behavioural control of safety compliance when they perceive that their organisations have higher level of HRO characteristics.
Hypothesis 6a (H6a): HRO has positive impacts on attitude of safety compliance.
Hypothesis 6b (H6b): HRO has positive impacts on norms of safety compliance.
Hypothesis 6c (H6c): HRO has positive impacts on perceived behavioural control of safety compliance.

4. Research Method

The questionnaire survey was developed from the research model and it took around 20-30 minutes to complete. The questionnaire measured the factors affecting safety compliance. The measurement items of the constructs were adapted from the existing literature to fit the context of construction industry: (1) HRO (Weick & Sutcliffe, 2007); (2) perceived quality of safety rules and procedures (Health and Safety Executive, 1995); (3) attitude (Ajzen, 2015b; Francis et al., 2004; Health and Safety Executive, 1995); (4) norms (Ajzen, 2015b; Francis et al., 2004; Health and Safety Executive, 1995); (5) perceived behavioural control (Ajzen, 2015b; Francis et al., 2004; Health and Safety Executive, 1995); (6) intention (Fogarty & Shaw, 2010); (7) safety compliance (Griffin & Hu, 2013); (8) safety violations (Fogarty & Shaw, 2010); (9) safety participation (Griffin & Hu, 2013). The measurement items adopted the seven-point Likert-style because Ajzen (2015b) and Francis et al. (2004) suggest it for the TPB questionnaires and most TPB studies adopt this scale. The demographic variables were developed from Barrientos-Gutierrez et al. (2007). The pilot survey tested those items and there were several changes made subsequently.

The data were collected from March to August 2017. Different construction companies were invited to participate in the main survey. There were two large main contractors willing to participate in the survey. Company A allowed the researcher visiting the safety center for distributing the questionnaire during the safety training course whereas the safety department of Company B helped distributing the questionnaire during rest breaks and lunchtime. The web-based self-administration system "LimeSurvey" was also developed but only few responses were received eventually.

A total number of 795 questionnaires were received (Company A: 463; Company B: 308 and LimeSurvey: 24). There were 365 valid and complete responses in total for analysing safety compliance of the construction workers in Hong Kong (Company A: 233; Company B: 130 and LimeSurvey: 2). The respondents mainly worked for main contractors (49.3%) and subcontractors (40.9%). Most of them (94.6%) worked in construction site and only 5.4% worked in office including site office. 93.9% of the respondents were male with only 6.1% respondents were female. Over half of them (54.0%) were within the age group of 25-34 and 35-44 whereas about one third of them (35.5%) were within the age group of 45-54 and 55 and over representing elder construction practitioners. The remaining respondents (10.5%) were at the youngest age group of 18-24. The education levels of the respondents were mainly secondary school level (53.9%) and above secondary school level (26.2%). More than two third of them (69.0%) were married and 64.8% lived with their children. Chinese (84.3%) was the main race followed by Nepalese (12.4%) and they constituted the major proportion (95.7%).

In company A, a small-scale discussion about 5 to 10 minutes was also held for respondents sharing their views after the questionnaire survey. Two open-ended questions were asked: (1) What factors would affect your safety behaviour? (2) What is your opinion on the safety rules and procedures of the company or organisation your currently work for? Supermarket vouchers were distributed for engaging the participation. Their views were recorded and organised as anecdotal quotes in the discussion below.

5. Findings

Statistical Package for the Social Sciences (SPSS) was used for calculating reliability and conducting factor analysis. Analysis of a Moment Structures (AMOS) was used to carry out Structural Equation Modelling (SEM). All the items reflected acceptable reliability that their Cronbach's alpha is higher than the cut-off value of 0.7 (Nunnally, 1978, as cited in Field, 2013, p. 709) with the exception of the alpha value of SP was 0.689 so SP was excluded from further analyses. Factor analysis helps understand the structure of a set of variables (Field, 2013). Principal components analysis (PCA) was adopted in this study for reducing a large set of variables to a smaller set (Dancey & Reidy, 2011).

After the PCA was conducted for each construct, Structural equation modelling (SEM) was then carried out. There are two components within a model, which are the measurement model and the structural model: the frontier prescribes which measured variables are indicators of a latent variable (factor) whereas the later defines the relationship among latent variables (Field, 2000). Anderson and Gerbing (1988) advocate a two-step approach to model testing despite SEM can anlayse direct and indirect relationships among latent and observed variables simultaneously (Crockett, 2012). Based on their advocation, the Confirmatory Factor Analysis (CFA), model fit and convergent validity of each construct were analysed first. The model fit and discriminant validity of the overall measurement model were then analysed. After that, the structural model was tested.

For individual construct, modification of the model is required if the model is not able to achieve the acceptable fitness indices (Crockett, 2012). First, the items were removed for improving the model fit if the standard estimate of the items was less than the required 0.50 level. Second, the modification indices (M.I.) for the covariances were referred to covary error terms that are part of the same factor and the largest modification indices were addressed first (Gaskin, 2018).

Similar to the measurement model, the fitness of the structural model needed to be examined first. The modified structural model fitness indices were: Chi-square/df=2.687 <3, p-value = 0.000, TLI=.819, CFI=.836, RMSEA=.068. The CMIN/DF showed acceptable fit and TLI, CFI and RMSEA achieved marginal fit so the construct was not modified further. Figure 2 shows the results of standardised estimates and model fit indices for the modified structural model and Table 1 shows the path estimates of the model and significance levels.

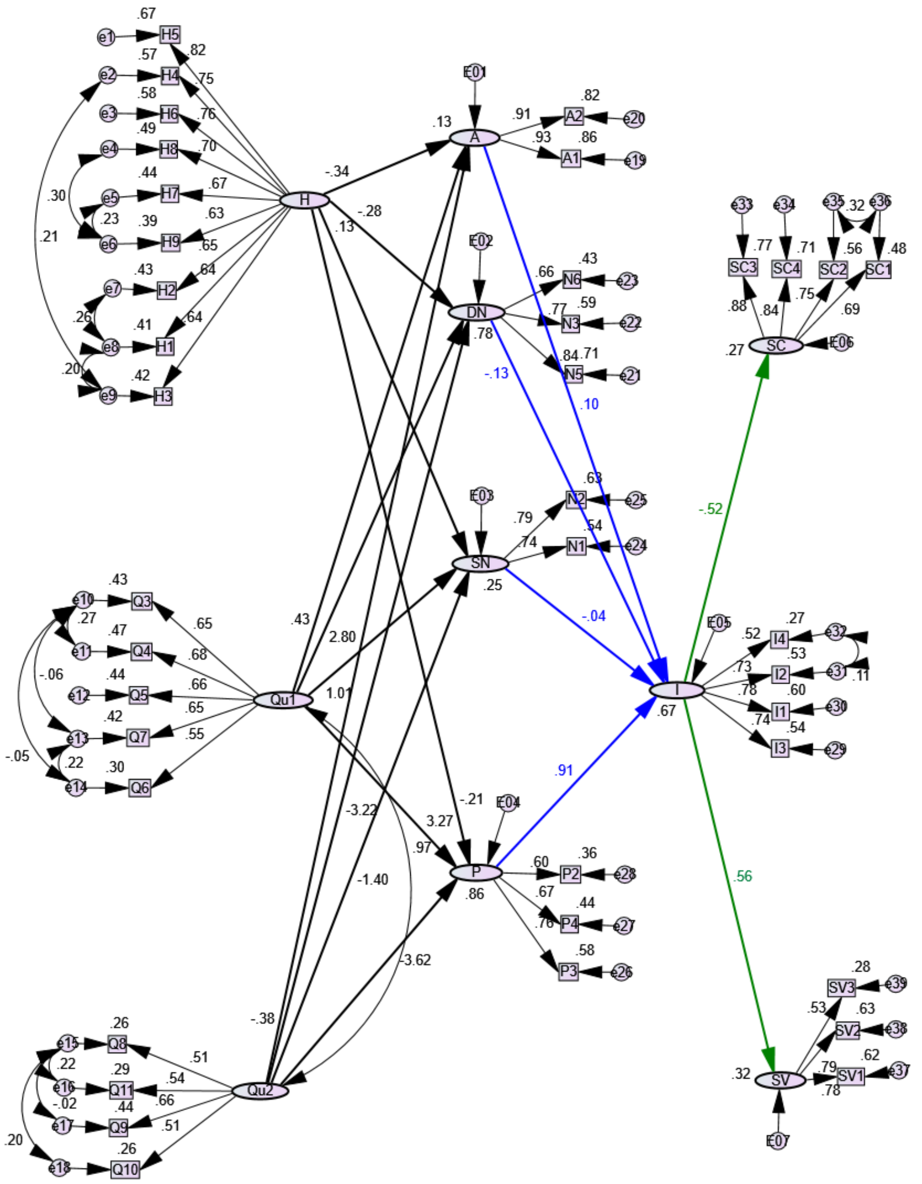

Figure 2: Standardized Parameter Estimates of Modified Structural Model (Chi-square/df=2.687, p-value = 0.000, TLI=.819, CFI=.836, RMSEA=.068)

Table 1: Unstandardized Parameter Estimates of Modified Structural Model

			Estimate	S.E.	C.R.	P
A	<---	HRO	-.417	.070	-5.916	***
DN	<---	HRO	-.372	.076	-4.912	***
SN	<---	HRO	.137	.068	2.013	.044
P	<---	HRO	-.265	.074	-3.600	***
A	<---	Qu1	.563	.372	1.515	.130
DN	<---	Qu1	4.059	1.240	3.274	.001
SN	<---	Qu1	1.203	.524	2.297	.022
P	<---	Qu1	4.419	1.369	3.228	.001
A	<---	Qu2	-.567	.413	-1.375	.169
DN	<---	Qu2	-5.274	1.407	-3.749	***
SN	<---	Qu2	-1.881	.604	-3.115	.002
P	<---	Qu2	-5.535	1.545	-3.583	***
I	<---	A	.098	.050	1.974	.048
I	<---	DN	-.118	.128	-.922	.356
I	<---	SN	-.042	.068	-.619	.536
I	<---	P	.902	.160	5.625	***
SC	<---	I	-.402	.048	-8.345	***
SV	<---	I	.365	.045	8.161	***

Although H1c was excluded due to the low internal consistency of safety participation, H1a and H1b were confirmed that there were significant impacts of intention on safety compliance and safety violations. Intention of safety violations had negative impacts on self-reported safety compliance. The regression weight for intention in the prediction of safety compliance was significantly different zero at 0.001 level (two-tailed). When intention went up by 1, safety compliance went down by -0.52. Contrary to safety compliance, intention of safety violations had positive impacts on self-reported safety violations. The regression weight for intention in the prediction of safety violations was significantly different zero at 0.001 level (two-tailed). When intention went up by 1, safety violations went up by 0.56.

H2 and H3 were confirmed. The significant positive impact of attitude on the behavioural intention to safety violations was found. The regression weight for attitude in the prediction of intention was significantly different zero at 0.05 level (two-tailed). When attitude went up by 1, intention went up by 0.10. Regarding perceived behavioural control, its significant positive impact on the intention of safety violations was found. The regression weight for perceived behavioral control in the prediction of intention was significantly different zero at 0.001 level (two-tailed). When perceived behavioural control went up by 1, intention went up by 0.91. On the contrary, H4 was refuted that there were insignificant negative impacts of subjective and descriptive norms on intention.

The significant positive impacts of perceived quality of safety rules and procedures on attitude, norms and perceived behavioural control of safety compliance were refuted in this study. It is because Quality 2 and Quality 1 were found to have significant negative and positive prediction on descriptive norms, subjective norms and perceived behavioural control of safety violations respectively.

In this study, the results are consistent with other studies that HRO have significant positive impacts on attitude, descriptive norms and perceived behavioural control of safety compliance (i.e. negative statistical effect on safety violations). H6a and H6c were confirmed. The regression weight for HRO in the prediction of attitude was significantly different zero at 0.001 level (two-tailed). When HRO went up by 1, attitude of safety violations went down by -0.34. For the prediction of perceived behavioural control, the regression weight was significantly different zero at 0.001 level (two-tailed). When HRO went up by 1, perceived behavioural control of safety violations went down by -0.21. H6b was refuted as HRO showed significant positive and negative prediction on subjective norms and descriptive norms of safety violations respectively at the same time.

6. Discussion

6.1 Safety in Workers' Hand

The significant relationship between the workers' intention and their self-reported safety compliance supports the stipulation in the TPB that intention being the most proximal predictor. The workers themselves can be the key to safety as they would have control over their safety behaviour.

6.2 Proximal Factors

6.2.1 Perceived Behavioural Control

Perceived behavioural control was the strongest factor affecting intention. Workers may think that they are able to get the job done without following safety rules and procedures. Their "can do" attitude creates vicious circle by never saying no to unreasonable demands from clients on speed, such as the four-day floor cycle can hardly be achieved in other locations (Rowlinson, Yip & Poon, 2008).

> ***Place undue emphasis on being fast.*** *Catching up the progress would affect safety behaviours in two aspects (1) workers themselves and (2) use of equipment. There is* ***much safety knowledge and most people are too rushed****.*
> *Using scaffolding as an example, workers know that it is safer but there is insufficient time to erect the scaffold for them. Eventually, they work by themselves so safeness was reduced.*

The respondents believed that they have sufficient safety knowledge and know how to work safe. Instead, they were too pressurised to complete the works quickly so they sometimes decide to work without following the safety rules and procedures. The external influence may due to the insufficient resources caused by short construction cycle and enormous number of infrastructure projects in the Hong Kong construction industry over recent years. Not only the workers but also the whole industry was forced to catch up the progress.

6.2.2 Attitude

The workers' attitude also significantly affected the intention but its effect was much weaker than perceived behavioural control. In the construction industry, the workers weigh short-term economic benefit over long-term safety consequences.

The mindset of "catch up progress" outweighs.

A respondent expressed that the workers pritorise construction progress. The phenomenon can be explained by the way how they are paid. Most workers are not monthly employees and paid on daily basis. Using carpenters as an example, some skillful carpenters are even "gangs", i.e. subcontractors further subcontract part of the works, such as by floor to workers. The workers are paid with bonus if they can complete that part of the works in time. This type of incentive is common for projects with tight schedule that substantiates the reality that site progress always becomes the top priority.

A respondent also indicated that they would put more emphasis on safety to prevent punishment and receive award if their companies implement intensive safety control and incentive schemes.

Inspection (punishment) and monetary award would affect their safety behaviour.

6.2.3 Norms

Norms were refuted with insignificant findings that are not in line with the literature. Nevertheless, norms may be an indirect factor affecting intention through perceived behavioural control and attitude. For instance, the mindset of "catch up progress" may be instilled in the construction workers' mind from subjective norms and descriptive norms of the coworkers and supervisors.

6.3 Distal Factors

6.3.1 High Reliability Organising (HRO)

HRO affects the perceived behavioural control, attitude and descriptive norms significantly. The result sheds light on the importance of HRO since it originates the proximal factors which consequently affect the intention of safety compliance. The findings are in line with the advocation in Rowlinson, Yip and Poon (2008) that the maturity of organisations is one of the aspects where new initiatives need to be developed in the Hong Kong construction industry.

6.3.2 Perceived Quality of Safety Rules and Procedures

Although perceived quality of safety rules and procedures does not significantly affect the proximal factors, the respondents' feedback indicates several areas for improving safety rules and procedures.

*Current situation is **too formalized**. We **do not know the purpose** of safety rules and procedures. We have too much equipment.*
*Safety rules are **infeasible**. We need to use safety belt all the time but how about at the staircase?*

In Hong Kong, the head office of construction companies establish the safety guidelines, rules and procedures and then they are implemented by site offices. The workers are usually not engaged in safety management. They are the "followers" of the safety rules and procedures. There are no well-established mechanisms to ensure that the "followers" grasp the meaning of safety rules and procedures thoroughly. They may at first not able to understand the purpose of safety rules and procedures due to their education level. Consequentially, they establish negative perception on safety rules and procedures and become reluctant to comply with them. The negative impression may also be caused by the current setting of safety training.

It would be better to conduct training in construction sites (morning assembly).
Training can improve safety behaviour but workers do not have income when attending training.

Although the workers acknowledge the benefit of safety training, they pinpoint some ways of improvement. Safety training can be enhanced by conducting more regular sessions in construction sites during morning assemblies or breaks. First, they can be more interested and engaged than in the classroom setting. Second, the regular training can help workers recap the safety knowledge and be aware of new dangers that are specific to their sites. Third, their work would not be affected as the regular training only takes a short period of time.

7. Conclusion

The research model was developed for examining the proximal and distal factors that interact with each other in construction projects. This study has successfully identified the significance of perceived behavioural control and attitude to the workers' intention of safety compliance. Relevant interventions shall be developed for improving the workers' intention since it will improve their safety compliance level in return. Apart from this, HRO shall be advocated in construction organisations.

It shall be acknowledged that there are recurring problems in the whole system for individuals, different sets of workers and organisations. Instead of the workers being entirely liable for their safety behaviour, it takes two to tango. The management shall actively and continuously discuss safety policies with the workers, listen and respond to their views. Safety engagement is to be the next step for safety management in the Hong Kong construction industry.

References

Ajzen, I., 2017. *Theory of Planned Behavior with Background Factors*. [html] Available at: <http://people.umass.edu/aizen/tpb.background.html> [Accessed 18 February 2018].

Ajzen, I., 2015. *TPB Model*. [html] Available at: < http://people.umass.edu/aizen/tpb.diag.html> [Accessed 21 November 2015].

Ajzen, I., 2015b. *Constructing a Theory of Planned Behavior Questionnaire*. [pdf] Available at: <http://people.umass.edu/aizen/pdf/tpb.measurement.pdf> [Accessed 21 November 2015].

Ajzen, I., 1991. The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50(2), pp.179-211.

Anderson, J. C. and Gerbing, D. W., 1988. Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, 103(3), pp.411-423.

Barrientos-Gutierrez, T., Gimeno, D., Mangione, T. W., Harrist, R. B. and Amick, B. C., 2007. Drinking social norms and drinking behaviours: A multilevel analysis of 137 workgroups in 16 worksites. *Occupational and Environmental Medicine*, 64(9), pp.602-608.

Cox, S. J. and Cheyne, A. J. T., 2000. Assessing safety culture in offshore environments. *Safety Science*, 34, pp.111-129.

Crockett, S. A., 2012. A five-step guide to conducting SEM analysis in counseling research. *Counseling Outcome Research and Evaluation*, 3(1), pp.30-47.

Dancey, C. P. and Reidy, J., 2011. *Statistics without maths for psychology*. 5th ed. Harlow, England: Pearson Education.

Field, A., 2013. *Discovering statistics using IBM SPSS statistics*. 4th ed. London, England: Sage Publications.

Field, A., 2000. *Structural Equation Modelling*. [html] Available at: < http://www.statisticshell.com/docs/sem.pdf> [Accessed 2 July 2016].

Flin, R., Mearns, K., O'Connor, P. and Bryden, R., 2000. Measuring safety climate: Identifying the common features. *Safety science*, 34(1), pp.177-192.

Fogarty, G. J. and Shaw, A., 2010. Safety climate and the Theory of Planned Behavior: Towards the prediction of unsafe behavior. *Accident Analysis & Prevention*, 42(5), pp.1455-1459.

Francis, J., Eccles, M. P., Johnston, M., Walker, A. E., Grimshaw, J. M., Foy, R., Kaner, E. F. S., Smith, L. and Bonetti, D., 2004. *Constructing questionnaires based on the theory of planned behaviour: A manual for health services researchers*. [html] Available at: <http://openaccess.city.ac.uk/1735> [Accessed 24 October 2015].

Fugas, C. S., Silva, S. A. and Meliá, J. L., 2012. Another look at safety climate and safety behavior: Deepening the cognitive and social mediator mechanisms. *Accident Analysis & Prevention*, 45, pp.468-477.

Gaskin, J., 2018. *Confirmatory factor analysis*. [html] Available at: <http://statwiki.kolobkreations.com/index.php?title=Confirmatory_Factor_Analysis> [Accessed 30 April 2018].

Griffin, M. A. and Hu, X., 2013. How leaders differentially motivate safety compliance and safety participation: The role of monitoring, inspiring, and learning. *Safety Science*, 60, pp.196-202.

Haslam, R. A., Hide, S. A., Gibb, A. G. F., Gyi, D. E., Pavitt, T., Atkinson, S. and Duff, A. R., 2005. Contributing factors in construction accidents. *Applied Ergonomics*, 36(4), pp.401-415.

Health and Safety Executive., 1995. *Improving compliance with safety procedures – Reducing industrial violations*. [pdf] Available at: <http://www.hse.gov.uk/humanfactors/topics/improvecompliance.pdf> [Accessed 19 March 2016].

Hudson, P. T., Verschuur, W. L. G., Parker, D., Lawton, R. and van der Graaf, G., 1998. *Bending the rules: Managing violation in the workplace*. [pdf] Available at: <http://www.eimicrosites.org/heartsandminds/userfiles/file/MRB/MRB%20PDF%20bending%20the%20rules.pdf> [Accessed 22 March 2016].

Labour Department, 2017. *Occupational safety and health bulletin*. [pdf] Available at: < http://www.labour.gov.hk/eng/osh/pdf/Bulletin2016.pdf> [Accessed 18 February 2018].

Langford, D., Rowlinson, S. and Sawacha, E., 2000. Safety behaviour and safety management: Its influence on the attitudes of workers in the UK construction industry. *Engineering, Construction and Architectural Management*, 7(2), pp.133-140.

Lawton, R., 1998. Not working to rule: Understanding procedural violations at work. *Safety Science*, 28(2), pp.77-95.

Noy, Y. I., Hettinger, L. J., Dainoff, M. J., Carayon, P., Leveson, N. G., Robertson, M. M. and Courtney, T. K., 2015. Editorial: Emerging issues in sociotechnical systems thinking and workplace safety. *Ergonomics*, 58(4), pp.543-547.

Reason, J., 2008. *The human contribution: unsafe acts, accidents and heroic recoveries*. Farnham, England: Ashgate Publishing Ltd..

Rowlinson, S., Yip, B. and Poon, S. W., 2008. *Safety initiative effectiveness in Hong Kong: One size does not fit all*. [pdf] Available at: < http://www.irbnet.de/daten/iconda/CIB_DC24446.pdf> [Accessed 9 April 2017].

Weick, K. E. and Sutcliffe, K. M., 2007. *Managing the unexpected: Resilient performance in an age of uncertainty*. 2nd ed. Hoboken, NJ: John Wiley & Sons.

Appendix

Table 2: Measurement of Constructs

Construct	Description of measurement items	Key source(s)
High Reliability Organising (9 items[a])	1. We have a good "map" of each person's talents and skills. 2. We talk about mistakes and ways to learn from them. 3. We discuss our unique skills with each other so that we know who has relevant specialized skills and knowledge. 4. We discuss alternatives as to how to go about our normal work activities. 5. When discussing emerging problems with coworkers, we usually discuss what to look out for. 6. When attempting to resolve a problem, we take advantage of the unique skills of our colleagues. 7. We spend time identifying activities we do not want to go wrong. 8. When errors happen, we discuss how we could have prevented them. 9. When a crisis occurs, we rapidly pool our collective expertise to attempt to resolve it.	Weick & Sutcliffe, 2007
Perceived quality of safety rules and procedures (12 items[a])	1. The rules do not always describe the best way of working. 2. Schedules seldom allow enough time to do the job according to the rules. 3. There are some rules which would make the job less efficient. 4. Some rules are impossible or extremely difficult to apply. 5. Rules commonly refer to other rules. 6. Some rules are factually incorrect. 7. Sometimes the operating limits prescribed in rules are too restrictive. 8. Some rules do not need to be followed to get the job done safely. 9. Some rules are only of value to protect management's back. 10. There is no efficient procedure to monitor that rules are kept to. 11. Working to the rules removes skills. 12. I have rules for tasks I will never have to do.	Health and Safety Executive, 1995
Attitude on safety violations (2 items[a])	1. Strictly following rules and procedures is good. 2. Strictly following rules and procedures is worthwhile.	Ajzen, 2015b; Francis et al., 2004; Health and Safety Executive, 1995
Norms on safety violations (6 items[a])	Subjective norms 1. Supervisor recognises that deviations from rules are unavoidable. 2. Coworker and workgroup recognise that deviations from rules are unavoidable. Descriptive norms 3. Supervisor sometimes pressure people to break rules. 4. Supervisors seldom discipline workers who break rules. 5. Coworker and workgroup sometimes pressure people to break rules. 6. Coworker and workgroup adopt different safety standards.	Ajzen, 2015b; Francis et al., 2004; Health and Safety Executive, 1995

Table 2: Measurement of Constructs (Cont'd)

Perceived behavioural control on safety violations (4 items[a])	1. Sometimes conditions at the workplace stop me working to the rules. 2. I have found better ways of doing my job than those given in the rules. 3. I can get the job done quicker by ignoring some rules. 4. Insufficient resources sometimes result in rules being broken to get the job done.	Ajzen, 2015b; Francis et al., 2004; Health and Safety Executive, 1995
Intention on safety violations (4 items[a])	1. I am prepared to take risks, other than those inherent in my job, to get a task done. 2. I am prepared to take shortcuts to get a task done. 3. It is necessary for me to take risks, other than those inherent in my job, to get a task done. 4. I am prepared to undertake a task a better way if I consider the approved or process to be overly cautious or inefficient.	Fogarty & Shaw, 2010
Safety compliance (4 items[b])	1. I carry out work in a safe manner. 2. I use all necessary safety equipment to do my job. 3. I use the correct safety procedures for carrying out my job. 4. I ensure highest level of safety when I carry out my job.	Griffin & Hu, 2013
Safety violations (3 items[b])	1. When given a task, I ensure that approved procedures are followed. 2. I have performed a familiar task with referring to the safety manual or other approved documentation. 3. Even with a view to completing a task on time, I would not deliberately "bent" formal procedures.	Fogarty & Shaw, 2010
Safety participation (3 items[b])	1. I put in extra effort to improve the safety of workplace. 2. I help my co-works when they are working under risky or hazardous conditions. 3. I voluntarily carry out tasks or activities that help improve work place safety.	Griffin & Hu, 2013
[a] The scale of the measure is as follows: 1 = strongly disagree; 2 = disagree; 3 = sometimes disagree; 4 = neither disagree nor agree; 5 = sometimes agree; 6 = agree; 7 = strongly agree.		
[b] The scale of the measure is as follows: 1 = never; 2 = rarely; 3 = occasionally; 4 = sometimes; 5 = frequently; 6 = usually; 7 = always.		