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Analysis of the Knowledge, Attitude and Practice of Multiple Designers Towards Prevention-through-Design (PtD) Implementation to Malaysia's Construction Industry

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Abstract: Statistics as evidence reported by the Department of Occupational Safety and Health (DOSH) shows that the construction sector recorded the highest rate of deaths compared to other sectors such as manufacturing and agriculture. It is suggested that early implementation on safety and health element in the construction project by the responsible parties, or Prevention-through-Design (PtD) concept could minimize the occupational safety and health hazards and risks, and further accident. This leads to this research which aims to investigate the knowledge, attitude and practice (KAP) of multiple designers in Malaysia's construction industry towards PtD implementation. Data was collected from multiple designers in Kuala Lumpur and Selangor using questionnaires and semi-structured interviews. The results showed that the designers' knowledge and attitude on PtD were well-aware by the designers and the concept was well accepted. However, the practice for PtD still needs many improvements. This study is important to raise awareness about the safe design among the designers. In addition, this study also helps in investigating where Malaysia's construction industry stands through the act of KAP of PtD by the construction stakeholders.

Keywords: Prevention-Through-Design (Ptd), Construction, Occupational Safety And Health, Construction Designers

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1. Introduction

Despite playing a significant role in the economy, the construction industry is listed as one of the most dangerous sectors [1]. In Malaysia, the poor safety performances of the construction industry are evidenced by the accident statistics reported by DOSH [2] and The Star [3]. Thus, one of the initiatives to improve the safety performance is through Prevention through Design (PtD) concept. The concept of PtD is implemented which brings the definition of practice in designing and forecasting potential occupational safety and health hazards as well as risks affiliate with the new process, structures, equipment and tools, organizing work in a manner that takes into account in construction, maintenance and disposal/recycling of waste material and recognizing the business and social benefits of doing so [4].

The concept of Prevention through Design (PtD) or known as Design for Safety (DfS) and Safety by Design in other countries is already implemented and accepted widely in other countries such as in Australia, the United Kingdom, the United States of America and Singapore. Guidelines and legislation on this concept have also been introduced to ensure full implementation of the concept [5]. Even though it has been introduced for decades, the awareness, knowledge and practice of the designers are still doubted. For example, a recent study by Toh et al. [6] in Singapore revealed that even though the multiple designers showed a positive attitude towards Design for Safety (DfS), the knowledge on the concept needs to be improved. The result from the survey showed that the practice of the DfS concept was after all, unformed and impoverished in the construction industry

This study seeks to investigate the knowledge, attitude and practice of the PtD concept in the construction industry by adapting Toh et al. [6] and Goh & Chua [7] method on conducting the survey. This study also emphasizes the significance of occupational safety and health hazards and risks in the construction industry. In order to achieve the aim, two objectives had been highlighted, as follows:

i) To investigate the knowledge, attitude and practice (KAP) of multiple designers in Malaysia's construction industry towards PtD concept; and
ii) To recommend potential interventions to improve the Prevention through Design implementation in the construction industry.

2. Prevention through Design (PtD) in Malaysia

The principle of PtD in Malaysia is still relatively new. It was implanted in the Guidelines of Occupational Safety and Health in Construction Industry (Management). The initial draft was done from September to October 2016 and was released for public comments through online and seminars. Later, the final draft was reviewed from December 2016 to January 2017. Finally, the publication was done from February to March 2017. The guidelines were mainly adopted from the Approved Code of Practice (ACOP) for Construction Design and Management Regulations in the United Kingdom. Nonetheless, having access to various references and documents from many countries who have implemented the PtD principle, the guidelines also contain requirements from other countries [8].

The Guidelines on Occupational Safety and Health in Construction Industry (Management) (OSHCIM) 2017 was established to provide practical guidance to the client, designer and contractor on the management of safety, health and welfare when carrying projects involving structures [5]. The OSHCIM guidelines provided practical guidance to those with legal duties under the Occupational Safety and Health Act and the Factories and Machinery Act. The construction project team included client, designer and contractor. OSHCIM also explained what designers should do to comply with the law and recommended duties to manage their projects. As a whole, the duty and responsibility for occupational safety and health in construction should be reflected by the multiple designers in the industry's supply chain. The designers should work together to design OSH hazards out of the construction industry's processes and products. Working in a team also means the ability to identify

and eliminate or reduce is reasonably practicable, due to the foreseeable design risks to the safety or health of any person.

Applying the PtD principles brings many benefits in some way. PtD principle improves productivity from many aspects since hazards and risks have been designed out before the construction phase. Therefore, there will be a significant risk reduction in the construction site. PtD also decreases operating costs and maintenance work. Besides reducing costs and maintenance, PtD also avoids expensive reconstruction/remedial works. Although the practice of PtD is still at the minimal state, globally [9], the multiple designers should be well aware of how much benefit the concept of PtD brings in the construction industry, not just in the safety aspect but also in cost reduction. It is expected that the benefit of PtD will be increased in terms of improved safety. This is where the benefit-cost model should be developed to provide a means to assess PtD from a financial perspective [10].

PtD also involves all decision-makers, designers and construction participants to have the opportunity to contribute to PtD in bringing in their knowledge from the previous project to the present. This participation means that everyone has the responsibility and ownership of their safety, environment and end-users. Bringing forward the concept of PtD increases the design quality and reduce the cost wastage in a construction project [11].

2.1 Designer's knowledge and attitude about PtD concept

The role of designers in reducing construction accidents is emphasized by Hinze & Wiegand [12]. Trethewy et al. [13] argued that the designer could influence the safety and health outcome directly (selection of frame type, specification of materials and the design itself) and indirectly (selection of a procurement system, preparation of contract documentation, sequencing of the construction process, and decisions regarding contract duration). Smallwood [14] interviewed general contractors in South Africa and revealed that half of them agreed that 'design' was a significant factor that affects health and safety negatively. The majority of these contractors stated that there was a need for architects and design engineers to attend a safety education subject at university or technical college level.

Even though some legislations and guidelines defined the designer's roles and responsibilities in reducing accidents such as OSHCIM 2017, it was still doubtful that Malaysian construction designers adequately understand how to identify, assess and control occupational safety and health (OSH) risks in their designs. This assumption was based on the 'nature of the job/responsibility', in which designers were usually not involved in or responsible for OSH.

This was proven by Abas et al. [15] who studied about the designer's confidence and attitude towards Designing-for-ConstructionSafety (DfCS) implementation in Johor, Malaysia. The findings revealed that the respondents were confident of their ability to design for construction safety, though they were relatively less willing to implement the concept. This study demonstrated that significant effort was required to promote the benefits of DfCS in improving the safety performance of the construction industry so that it would be widely accepted and implemented by the construction stakeholders. Che Ibrahim & Belayutham [16] explored the PtD knowledge, attitude and practices (KAP) among 49 civil & structural (C&S) engineers towards OSHCI(M) implementation, and found that current state of C&S engineers' knowledge still requires improvement, particularly on the PtD principles. The practices of PtD were mostly work-in-progress, but the majority of them had been very supportive on the implementation of PtD. The authors also proposed measures to improve PtD implementation through external forces, dynamics industry and operational organization factors.

In Singapore, Goh and Chua [7] explored the DfS KAP of C&S engineers to guide further research in measuring and improving DfS KAP of designers, due to the critical role of C&S engineers during design and construction. It was found that there was a lack of KAP studies in construction management. The results suggested that C&S engineers were supportive of DfS, but the level of DfS knowledge and practices needed to be improved. More DfS guidelines and training should be made available to

engineers. Further, Toh et al. [6] investigated the DfS KAP of multiple construction stakeholders, which were architects, C&S engineers, mechanical and electrical (M&E) engineers, developers/clients, project managers, and safety professionals. The majority of respondents demonstrated a positive attitude towards DfS, but the average level of DfS practice was low, and statistically significant differences in DfS practice were found between developers/clients, CS engineers, and project managers. This study suggested three strategies for improving DfS implementation which proposed: (1) enhance DfS training programs, (2) establish a DfS Community of Practice, and (3) develop DfS courses in tertiary institutions.

3. Methods

3.1 Development of Survey Form

The first objective of the study involved collecting information on the knowledge, attitudes, and practice (KAP) of multiple designers in Malaysia's construction industry through questionnaires survey. The survey form used in this study was adopted from the validated questionnaire developed by Goh and Chua [7] which had done study on the KAP of DfS on multiple stakeholders of the Singapore construction industry. The questionnaires consisted of four (4) sections as detailed below:

i) Section A: Participant's Background - This part collected the information on the respondents' background such as discipline, position, working experience, and contact details.
ii) Section B: Knowledge question - This section was mainly to investigate the PtD knowledge of the different designers. Respondents were asked to rate from 1 (very low) to 5 (Very high) and 3 as the neutral level.
iii) Section C: Attitude question - The objective of this section was to assess the attitude of the multiple designers towards the concept of PtD. Respondents were asked to rate from 1 (not at all important) to 5 (very important).
iv) Section D: Practice question - This section was to examine the frequency of PtD practice and the types of challenges and key concern that the multiple designers face. The self-rating score was from 1 (Never) and 5 (Always).

Before distributing the original questionnaire forms, a pilot study was conducted to validate the questionnaire instrument by sending out the questionnaire to 10 panels of the experts, who had more than 15 years of experience in design activities. All panels agreed with the questionnaire instrument, which denoted that the adopted questionnaire was suitable to be used in the Malaysian environment.

Next, the questionnaire survey was distributed through two main platforms, which were through online platform i.e. google form (the link to the google form was sent to the companies who were contacted beforehand via email); and via self-administered to the companies along with an official letter by Faculty of Civil and Environmental Engineering to support the project. The questionnaires were distributed to multiple construction designers including Civil and Structural (C&S) Engineers, Mechanical and Electrical (M&E) Engineers, Architects, Quantity Surveyors and other relevant individuals. All of the respondents were working at the design companies in Selangor and Kuala Lumpur. These surveys were done during working hours, and each respondent had taken not more than 15 minutes to complete the survey.

A total of 91 surveys were collected, and the summary of the respondents was depicted in Table 1. The majority of the respondents were architects, followed by C&S engineers. Whilst the majority of respondents had less than 5 years of working experience. The majority of the respondents were aware of the PtD concept. A total of 76.92% of the respondents were aware of the PtD concept, which they heard and acknowledged through the company that they worked for, DOSH website, from institutions and also through seminars/conferences.

Table 1: Background of respondents

Description	Number of respondents
Discipline	
C&S engineers	20
M&E engineers	20
Architects	22
QS	18
Others (Project manager, Planner etc.)	11
Working experience	
More than 15 years	17 (18.68%)
11 to 15 years	11 (12.09%)
5 to 10 years	11 (12.09%)
Less than 5 years	52 (57.14%)
Awareness on PtD concept	
Yes	70
No	21

3.1.1 Reliability test for actual study

The Cronbach's Alpha reliability test was done on the questionnaire received, with the value of 0.721. This meant that the results of the questionnaire were reliable [17].

3.1.2 Measures for data analysis

The collected information was analyzed using SPSS. One sample t-test was done to determine if the means of the PtD knowledge, attitude and practice of the multiple designers differ from the neutral level (i.e., test value). A one sample t-test has the ability to determine whether the mean of a group differ from a specified value [18].

In addition, the data was analyzed to determine whether there was any statistically significant differences in mean between groups of designer (i.e., C&S Engineer, M&E Engineer, Architect and Quantity Surveyor) by using a One-way Analysis of Variance (ANOVA). Next, an independent samples t-test was conducted in order to obtain the comparison of the means of the self-perceived ratings between two groups of respondents who attended a Prevention through Design (PtD) training course and those who did not attend any PtD training course. Independent samples t-test was practical to compare the means between unrelated groups on the same dependent variable.

3.2 Interview

Meanwhile, interview was done with several designers to ask their opinions on the potential intervention to improve the Prevention through Design implementation in the Malaysian construction industry. Semi-structured interviews were conducted which consists of general questions to determine interviewees' opinions of the PtD KAP, potential obstacles, and critical success factors of PtD implementation. The interviewees were selected based on two (2) criteria which were: possessed PtD knowledge and possessed minimum of 10 years experience in the construction industry. The details of the designer selected were shown in Table 2.

Table 2: Details of the interviewees

Interviewee	Discipline	Year of experience
1	C&S Engineer	More than 15 years
2	C&S Engineer	5 to 10 years
3	Architect	More than 15 years
4	M&E Engineer	11 to 15 years

This interviews helped in obtaining a complementary information from different construction designers' perspective and investigated the current state of PtD KAP, challenges obstructing PtD practice and potential interventions that an improve PtD implementation.

4. Results and Discussion

4.1 Comparison of Means of Prevention through Design: Knowledge, Attitude and Practice among Designers

Section A, B and C in the questionnaire were analysed separately to obtain the mean for each designer group in terms of the questions in the respective section. The results were summarized in Table 3.

Table 3: Summary for the mean comparison of PtD knowledge, attitude and practice

Criteria	Question	Discipline	Mean	N	Standard Deviation
PtD Knowledge	Rate your understanding on the concept of PtD	C&S Engineer	2.80	20	1.281
		M&E Engineer	3.65	20	0.671
		Architect	3.05	22	0.844
		Quantity Surveyor	3.78	18	0.548
		Others	2.09	11	1.221
		Total	*3.15*	*91*	*1.064*
PtD Attitude	Rate the importance of implementation of PtD	C&S Engineer	4.50	20	0.827
		M&E Engineer	4.60	20	0.821
		Architect	4.32	22	0.716
		Quantity Surveyor	4.94	18	0.236
		Others	4.36	11	0.924
		Total	*4.55*	*91*	*0.749*
PtD Practice	Have you ever been asked to address construction worker health and safety in the design phase?	C&S Engineer	2.75	20	1.410
		M&E Engineer	2.35	20	.933
		Architect	2.64	22	1.620
		Quantity Surveyor	2.17	18	0.786
		Others	2.64	11	1.433
		Total	*2.51*	*91*	*1.268*

With regard to knowledge on PtD, the designers were asked to rate their understanding on the concept of PtD. Among these groups, Quantity Surveyor had the highest self-rating score of 3.78, followed by M&E engineers, architects, C&S engineers and others with the self-ratings score of 3.65, 3.05, 2.80 and 2.09 respectively. This result had shown that more PtD training courses should be focused on designers especially architects and C&S engineers to improve their understandings of PtD. This is essential as they usually involved in the design process from the start. They should be aware of PtD and the knowledge is important to design out of the hazards. In comparison with the previous study done by Toh, Goh and Guo (2016) on the KAP of DfS on the Singapore construction industry, the result on knowledge had shown almost having a similar value, in which the mean score was above the value 3.

Meanwhile, for questions-related to the attitude of designers towards PtD, the majority of the respondents thought that the implementation of PtD was very important (70.33%), where the mean rating for all designers was 4.11. The question asked on PtD attitude was a self-rating question "do you think the implementation of PtD is important". The ratings were from 1 (not at all important) to 5 (very important). Fortunately, there was no negative attitude towards the implementation of PtD by the designers. All of the respondents thought that the implementation of PtD was "important", "fairly

important" and "very important". The self-rating score also showed that Quantity Surveyors had the highest mean score of 4.94. The mean rating of 4.11 for multiple designers indicated that all respondents perceived PtD implementation as "fairly important" and "very important". The results were in agreement with the previous study by Toh et al. [6].

Although the majority of respondents showed a positive attitude on PtD, PtD practice remained immature in the Malaysia's construction industry. The question asked to evaluate the practice of the PtD concept by the designer was also a self-rating score. The question was "have you ever been asked to address construction worker health and safety in the design phase?". The self-rating score was from 1 (Never) and 5 (Always). Out of all the 91 respondents, the majority (40.66%) answered that they were rarely had been asked to address construction worker health safety in the design phase. Figure 1 shows the percentage of the designers that had ever been asked to address construction workers about health and safety issues during the design phase. Apart from that, although Quantity Surveyors had the highest self-rating score in the knowledge and attitude section, the PtD practiced by Quantity Surveyor recorded the lowest which was 2.17. Moreover, all the other designers also recorded a mean score of below 3 which indicated that the majority of the designer's rate that they "never" and "rarely" been asked to address construction worker health and safety in the design phase.

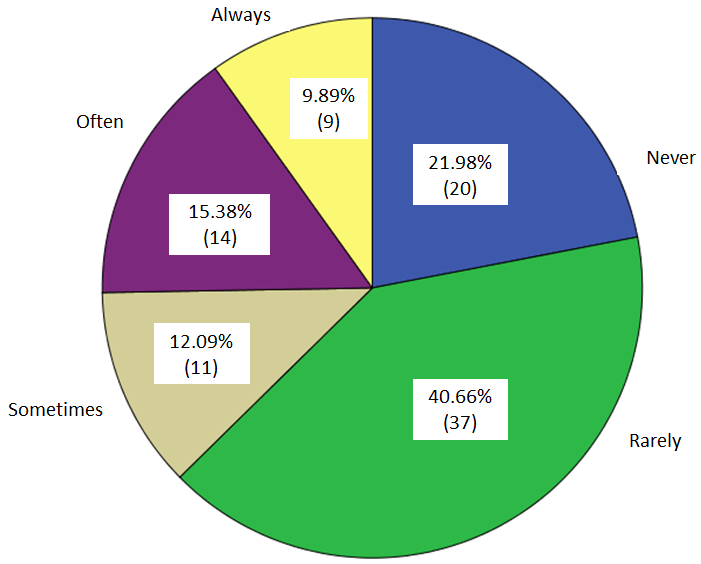

Figure 1: Percentage of the designers even been asked to address construction worker health and safety in the design phase

4.2 One Sample t-Test

A one-sample t-test was conducted to determine whether the respondent's level of KAP on PtD was statistically significantly different from the neutral level (a score of 3). As shown in Table 4, the mean of PtD knowledge score showed that the majority of the respondents rated their understanding of PtD concept as "average" with a sample mean [mean (M) = 3.15 and standard deviation (SD) = 1.064] was higher than the neutral level (score of 3). The PtD knowledge score showed a statistically significant difference of 0.15 [95% confidence interval, -0.07 to 0.38], t (91) = 1.38 and p = 0.171.] The majority of respondents were aware of PtD since the mean was higher than the neutral level.

The mean PtD attitude score [mean (M) = 4.55 and a standard deviation (SD) = 0.749] was also a higher value than the neutral level of score 3. This result also had shown that the majority of the respondents showed a positive attitude towards PtD concept. The statistically significant difference was 1.55 [95% confidence interval, 1.39 to 1.71], t (91) = 19.727 and p = 0.00]. A p-value of less than 0.05 implies that the result was significant.

Meanwhile, for the PtD practice score, the mean recorded was [mean (M) = 2.51 and a standard deviation (SD) = 1.268]. This score showed a contrast compared to the knowledge and attitude score. It was lower than the neutral level of 3. This indicated that the PtD concept was not widely practiced within the groups of the designer. The statistically significant difference was -0.49 [95% confidence interval, -0.76 to -0.23], t (91) = -3.720 and p = 0.00. The result for PtD also indicated that it was significant. The descriptive result of the one-sample t-test was shown in Table 5.

Table 4: Descriptive statistics of one sample t-test

Knowledge, Attitude and Practice	Sample size (N)	Mean	Standard deviation	Standard error mean
Rate your understanding on the concept of Prevention through Design (PtD).	91	3.15	1.064	0.112
Do you think the implementation of Prevention through Design (PtD) is important?	91	4.55	0.749	0.079
Have you ever been asked to address construction worker health and safety in the design phase?	91	2.51	1.268	0.133

Table 5: One sample t-test on the levels of knowledge, attitude and practice of the designers

Knowledge, Attitude and Practice	Question	*t*	Degrees of Freedom	Sig. (2-tailed)	Mean Diff.	95% confidence interval of the difference	
						Lower	Upper
PtD knowledge	Rate your understanding on the concept of PtD.	1.380	90	0.171	0.154	-0.07	0.38
PtD attitude	Do you think implementation of PtD is important?	19.727	90	0.000	1.549	1.39	1.71
PtD practice	Have you ever been asked to address construction worker health and safety in the design phase?	-3.720	90	0.000	-0.495	-0.76	-0.23

4.3 One-way ANOVA

A one-way analysis of variance (ANOVA) test was performed to determine whether there were any statistically significant differences in PtD knowledge, attitude and practice between the groups of designers. ANOVA test was a useful test to determine if there were any statistically significant differences between the means of three or more independent groups. For this testing, the hypothesis for null and alternative testing were:

$$H_o = The\ sample\ means\ between\ groups\ are\ equal.$$
$$H_a = The\ sample\ means\ between\ groups\ are\ not\ all\ equal$$

As shown in Table 6, there were statistically significant differences in PtD knowledge among the designers since the p-values of 0.000. For the ANOVA test, there would be a statistically significant difference when the p-value is more than 0.05. When a one-way ANOVA test have shown a statistically significant difference in the result, we accepted the alternative hypothesis (Ha) in which for this study, we accepted that not all of the sample means were equal. The knowledge of the concept needed to be

improved and major action should be taken in order to increase the awareness of the PtD concept among the designers in the construction industry.

However, there was no statistically significant difference in PtD attitude and practice between the designers as determined by the ANOVA test with the p-values of 0.09 and 0.660. We accepted the null hypothesis which was the mean between groups was equal. This indicated that the PtD attitude and practice towards the concept was still immature and underdeveloped. In comparison to the previous study by Toh et al [6], the results were contradicting with each other. The result obtained was different. The results obtained for this study showed that the mindset and practice of the designers towards safety in designing were still doubted. There was still room for many improvements in encouraging the designers to practice the PtD concept.

Table 6: One-way ANOVA test

Knowledge, Attitude and Practice	Question	Comparison	Sum of squares	df	Mean square	F value	Sig.
PtD Knowledge	Rate your understanding on the concept of PtD.	Between groups	27.121	4	6.780	7.80	0.000
		Within groups	74.725	86	0.869	3	
		Total	101.846	90			
PtD Attitude	Do you think implementation of PtD is important?	Between groups	4.465	4	1.116	2.08	0.090
		Within groups	46.063	86	0.536	4	
		Total	50.527	90			
PtD Practice	Have you ever been asked to address construction worker health and safety in the design phase?	Between groups	4.311	4	1.078	0.66	0.621
		Within groups	140.436	86	1.633	0	
		Total	144.747	90			

4.4 Independent Samples t-Test

An independent samples t-test was conducted for comparison within the means of the self-perceived ratings between two groups of "designers who have attended any PtD training course" and "designers who had not attended any PtD training course" (i.e., C&S Engineers, M&E Engineers, Architects, Quantity Surveyors and others). An independent sample t-test was useful to compare the means between two unrelated groups on the same continuous, dependent variable. Therefore, in this study, the dependent variable was the subject on whether the designers have or have not attended any PtD course. The independent variable was the multiple designers who had been participated in this study. As indicated in Table 7 and Table 8, the designers who attended a PtD training course had a statistically significantly higher mean of self-perceived ratings (M = 3.95 and SD = 0.226) compared to those who did not attend any PtD training courses (M = 2.58 and SD = 1.064), t (89) = 7.757, and p = 0.000.

Table 7: Mean difference between 'designers who have attended any PtD couse' and 'designers who have not attended any PtD course'

PtD knowledge	Have you attended any PtD training course?	Sample size (N)	Mean	SD	Std. error mean
Rate your understanding on the concept of PtD.	Yes	38	3.95	0.226	0.037
	No	53	2.58	1.064	0.146

Table 8: Independent samples t-test

		Levene's test for equality of variances		t-Test for equality of means						
Question	Equal var.	F Value	Sig.	t	Df	Sig. (2-tailed)	Mean diff.	Std. error diff.	95% confidence interval of the difference	
									Lower	Upper
Rate your understanding on the concept of PtD	Equal variances assume	54.85	0.000	7.76	89	0.00	1.36	0.18	1.013	1.711
	Equal variances not assume	-	-	9.04	58.44	0.00	1.36	0.15	1.061	1.664

4,5 Semi-structured Interviews

Semi-structured interviews were conducted to attained experts' opinions on the potential interventions to improve PtD implementation in the construction industry. All of the interviewees were aware of the PtD concept in the construction industry. A total count of 5 interviewees were selected from various designer groups.

When being asked about the types of design guidance that designers used to facilitate their design work in general, Interviewee 1 stated that "for architects, we followed the Uniform Building By-Laws (UBBL). The UBBL is a prescriptive building code that is compliant and the requirement by law. Besides that, UBBL sets rules and regulations on the application of the code and provides pre-determined prescriptions". Interviewee 1 also stated that "Occupational Safety Health and Environment (OSHE) and Department of Safety and Health (DOSH) was also the types of design guide that they used to facilitate their design work". Interviewee 1 thought that "a design guide that would assist them as an architect in carrying out PtD duties as a designer was a structural practical guide as issued by experienced safety professionals/Engineers".

Meanwhile, when asked about the ways to control the hazard, Interviewee 2 referred to Factories and Machinery (Buiding Operations and Works at Engineering Construction) (Safety) Regulations) 1986 as a reference guide for design works. For the other type of design guide interviewee 2 used was "guided by design according to the suitability of the worker to do the job safety". Meanwhile, Interviewee 3 highlighted to control hazards by capturing, enclosing or guiding the source of the hazard" and "separate the hazard from that being protected by imposing barrier.

With regard to the challenges in implementing PtD concept in Malaysia's construction industry, Interviewee 4 stated that "the mindset of addressing or eliminating hazards in construction was very unlikely. The mentality of most professionals in the construction industry needed to be intensified". According to Interviewee 3, some factors that were limiting in the implementation of PtD also included the cost, lacked resource/design guide and lacked commitment towards PtD. He also added that "in enhancing the PtD concept, the mindset of thinking lightly on the safety in designing and safety in the construction industry should not occur in the first place. Safety in the construction industry should be taken very seriously".

5. Conclusion

This study investigated the knowledge, attitude and practice (KAP) of multiple designers (including architects, C&S engineers. M&E engineers, QS and other relevant stakeholders in Malaysia's construction industry towards PtD concept to whom were working in Selangor and Kuala Lumpur. The designers' knowledge and attitude on PtD were well-aware by the designers and the concept was well accepted. However, the practice for PtD still needed many improvements. The analysis showed similarities with the previous study done by Toh et al. [6] in Singapore.

The survey results indicated that the PtD concept was not something new to the majority of the designers. Nonetheless, there were still designers in the construction industry who had never heard of PtD concept before. This showed that there were still more actions needed to be taken in order to spread the PtD concept to the whole construction industry. The result of One Samples t-Test from the data analysis indicated that the level of self-perception of PtD knowledge and attitude was statistically significantly higher than the neutral level which was the score of 3. However, the level of self-perceived PtD practice was statistically significantly lower than the neutral level indicated that the practice of PtD in the construction industry was still immature and undeveloped. This also showed that there was still room for improvement. In addition, the independent samples t-test indicated that there was a statistically significant difference in the level of self-perception of PtD knowledge between the designers who attended any PtD training course and those who did not attend of any course. This result showed that there was a significant difference in improving the designers' PtD knowledge. This survey marked that our construction industry was still negligent towards the demonstration of knowledge, attitude and practice of Prevention through Design.

In conclusion, the practice of PtD concept in the industry still needed many improvements, as highlighted in the interviews. The accidents in the construction industry could be prevented by having the mindset of preventing or eliminating hazards at source. This could decrease the number of accidents happen at the site. The behaviorism of reasoning safety was simply unimportant should not exist in construction industry personnel. More action on imprinting the importance of PtD concept should be applied as the safety in the construction industry and should be taken very vigorously. The future study is sought to be conducted for a larger number of respondents and to cover the respondents in all states in Malaysia to achieve more accurate results. Besides that, a study on how to enhance the PtD training course and the perception on designers on establishing a PtD community of practice could also be conducted as a continuation of this research.

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