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Bolstering Measures for Combating the Challenges of Safe Working Cycle Implementation in Hong Kong's Construction Industry

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Abstract: To heighten the safety performance of construction projects, multitudinous safety initiatives or measures have been promulgated in Hong Kong over the past three decades. These initiatives have led to the drastic reduction in construction site accidents. However, implementing these safety initiatives, such as the Safe Working Cycle (SWC), does not go without facing challenges. This paper illustrates the survey findings from an evaluation of the challenges encountered with the execution of SWC in construction projects in Hong Kong and proffers possible bolstering improvement measures for its successful implementation. The study was quantitative in nature and data were gathered from construction participants involved in projects adopting SWC. The data gathered were analysed using diverse descriptive, inferential and first-generation multivariate analyses. The study findings revealed that the effective implementation of SWC is still deterred by several major challenges that can be grouped into: (1) tight project schedule and limited site space; and (2) lack of promotions and support for SWC implementation. To address these profound challenges, the study recommended some essential improvement measures including: (1) adequate budget allocation and reasonable project schedule; (2) establishment of a reward system towards construction workers; and (3) development of a tailor-made SWC system for each specific construction site. The study has provided useful guidelines and insightful recommendations for both the client organisations and construction firms and their site management staff in developing their site safety policies and adopting SWC for improving the existing site safety performance of various construction projects.

Keywords: construction industry; health and safety; Hong Kong; site safety cycle; site safety performance; safe working cycle (SWC)

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1. Introduction

The issue of construction site safety has been a topical one in most industry and academic discourse. This is because, despite its high dependence on humans to deliver its products [1], the industry around the world is still plagued with injuries and fatalities [2–6]. The industry has been noted to be responsible for one out of every six deaths that occur in the workplace [3]. Accidents, including workers falling from heights, workers struck by falling objects, electrocution, and exposure to dangerous substances, are some of the main health and safety (H&S) threats in the construction industry worldwide [2,7]. To prevent the occurrence of these fatalities and injury-causing accidents, studies have continued to strive to unearth the causes of site accidents around the world. In China, Tam et al. [8] identified some major causes, including poor awareness of safety measures, training issues, lack of investment, and poor safety consciousness of workers. In Malaysia, Hamid et al. [9] noted issues such as negligence, absence of safety devices and measures, and poor management. The situation is no different in Nigeria, where Kadiri et al. [10] noted negligence as a principal culprit. In South Africa, Aghimien et al. [2] noted long working hours and poor safety culture as crucial causes of poor safety on construction sites. The case is no different in Hong Kong, where Tang et al. [11] noted workers' negligence, unsafe construction sites as well as inefficient management as the principal culprits of the poor safety performance of the construction industry. Therefore, developing and implementing safety measures to improve construction site safety and allow workers to function in an environment free of danger has become apparent [12–14].

In Hong Kong, several safety initiatives have been developed to help combat issues of the unsafe working environment and reduce workplace accidents. Among these initiatives are the Safety Management System, the Performance Assessment Scoring System, and the Pay-for-Safety Scheme, which were all introduced in 1994. In addition, there is also the Safe Working Cycle (SWC), which was introduced in 2002 and has continued to gain significant recognition for its inherent ability to promote safety awareness and cultivate a safe working culture among workers [14–17]. The SWC is designed to enhance the safety of construction workers by embedding safety management into the construction management system [18,19]. The use of this safety initiative has been observed in public sector projects in Hong Kong [17] and significant benefits have been reaped, such as establishing a safe working habit among construction workers, improving the safety reputation of construction organisations, and achieving reduced site accidents and better H&S records [20]. Based on these benefits, it is believed that SWC offers a solution to some of the causes of construction sites' poor safety that were identified earlier.

Although SWC is gaining popularity, the implementation of this initiative is still hampered by certain challenges. Unearthing these challenges and proffering possible solutions towards combating these issues is essential for the effective implementation of SWC and attaining improved safety performance in the construction industry. This becomes apparent as there is the absence of empirical works exploring these SWC issues and proffering possible solutions. Furthermore, although the implementation of diverse initiatives has helped mitigate construction site accidents in Hong Kong, the industry's accident rate is still comparatively high when assessed against the accident rates of other industries [21]. Hence, there is a pressing need to ensure that the available safety initiatives are properly implemented for improved safety performance. Along this line, this study was designed to empirically assess the challenges encountered with the implementation of SWC systems in construction projects in Hong Kong and determine the bolstering measures that could help improve the use of this system for optimum site safety. This was achieved to improve the safety of construction sites and ensure organisations gain improved safety reputations through effective use of SWC. The findings, therefore, offer practical guidelines and insightful recommendations for owners of construction organisations and their site management staff in shaping their site safety policies and adopting SWC for improved site safety performance of different construction projects.

2. Literature Review

In the same manner as its counterparts around the globe, Hong Kong's construction industry is no stranger to site accidents. According to the Labour Department's [22] statistics, the industry contributes to 35.2% of the cumulative accidents occurring in industries in Hong Kong. However, from 2000 to 2020, there has been a 78.8% reduction in the accident rate in the construction industry, as a drop from 11,925 in the year 2000 to 2532 in the year 2020 was recorded. Over the last 20 years, the Hong Kong Government has initiated several effective safety initiatives that have significantly contributed to the decline in workplace accidents (including in the construction industry) [14,17,23]. It is important to note that although the majority of the introduced safety initiatives are mandatory for public sector projects (i.e., projects funded and delivered by the government), they are voluntarily adopted in private sector projects (i.e., projects funded and delivered by individuals or entities from the private sector other than the government) [23]. One such safety initiative that is garnering significant attention, particularly in the construction industry, is the SWC—an initiative developed in Japan, which was intended to combat difficulties in management systems [24]. The Japanese construction industry witnessed a decline in the rate of site accidents after introducing the SWC, and as a result, the initiative is regarded as a plausible strategy for improving the safety performance on construction sites in Hong Kong, hence its introduction [20]. The first introduction of the SWC in Hong Kong was in 2000. This introduction was carefully crafted by embedding it in six contracts originally designed using the Pay-for-Safety Scheme initiative. After two years of success, SWC was formally introduced as a standalone safety initiative in August 2002.

Li and Poon [25] described the SWC as a well-structured safety management system with daily, weekly, and monthly cycles. The duration and activities in each cycle are determined by the urgency of each construction activities. Furthermore, understanding the primary causes of accidents on sites and proffering immediate solutions to avert these accidents and improve overall safety performance is one of the primary targets of this initiative [20]. Chan and Choi [23] noted that the daily cycle offers the most detailed approach to safety among the three cycles, while the weekly and monthly cycles offer broader perspectives. Using the SWC, job sites are expected to be kept tidy daily, and workers need to be aware of the necessary safety precautions available on site. Safety briefing for up to 15 min is required daily. This briefing encompasses pre-work physical exercise and reminding workers of safety hazards and precautions in place. A hazard identification meeting for up to ten minutes is also required, particularly for construction sites where specialised trades are working. At the end of these meetings and before the commencement of the day's job, a pre-work check-up and safety inspection must be conducted to ensure that the job site is safe for the day's activity to be conducted. Team representatives, project managers, site agents, and foremen must ensure appropriate guidance and supervision are given to site workers daily to ensure their safety. At the end of each workday, all workers must tidy up and the supervisors must conduct a final check to ensure the site is left safe and tidy for the next day's work [20,23]. For the weekly cycle, measures adopted in the previous week are evaluated through scrutiny of the issues faced and proffering solutions to better improve safety for subsequent weeks. On a weekly basis, project managers and site agents are expected to conduct safety inspections, while engineers and other competent persons on site are expected to conduct check-ups. Furthermore, process safety discussion must be held by project managers and other representatives, while tidying must be given adequate attention weekly by all workers on site (Occupational health and safety council, 2006). The monthly cycle allows for the review of recent site safety performances and work progress [23]. This is achieved through monthly inspections, safety meetings, and training [20].

The use of SWC on construction projects offers the safety of frontline workers through improved awareness and the cultivating of better safe working habits [15,17]. Moreover, this initiative offers increased safety commitment on the part of construction organisations and, at the same time, improves their safety reputation [17,19]. Furthermore, the Environment, Transport and Works Bureau [26] observed that the SWC provides improved communications on H&S issues between supervisors and workers. This has led to a significant reduction in site accidents [27,28]. Despite these attractive benefits offered by the SWC, its complete adoption in the Hong Kong construction industry has not been without its challenges. Studies have noted that although this safety initiative has been embraced within public works, the extent of its use in private works is still unclear as it is not mandatory [17,23]. Chan and Choi [23], through an in-depth interview, explored the difficulties facing the use of SWC and concluded that issues such as limited site space for workers to conduct the required morning exercise as well as the different time schedules for different construction activities are two major issues deterring SWC implementation. In Sri Lanka, Mendis et al. [19] mentioned that having overly tight project schedules, poor staff participation, and limited space to conduct meetings and exercise are challenges that the effective use of SWC in the country faces. In a similar study, Choi et al. [29] noted that challenges to effective safety initiatives could be categorised into workers, contractors, and subcontracting practice issues. In most cases, the poor literacy of construction workers coupled with a negative safety attitude can truncate the implementation of laudable safety initiatives [23,30,31]. Furthermore, having a limited budget that does not cater for the expenses required for the activities in the SWC might prove challenging for the successful implantation of the initiative [23,31]. Moreover, subcontractors' resistance to accepting the safety initiative can be a huge problem to its successful implementation [19,23]. Table 1 gives a summary of the perceived challenges associated with SWC execution to be assessed in the current study.

Table 1. Summary of the perceived challenges of implementing SWC in the construction industry.

Challenges of Implementing SWC	Sources
Limited site space to conduct morning physical exercise or activities.	[19,23,25]
Irregular working schedule for different trades at various stages of projects.	[23,25]
Resistance from subcontractors and workers to participate if the training venue is far away from job site.	[19,23,29,32]
Over-tight project schedule leading to rushed jobs.	[19,23]
Lack of motivation for workers to participate in SWC.	[23]
Insufficient financial support to cover necessary SWC items.	[23,31]
Inadequate education or promotions from government.	[23]
Unfamiliarity with SWC by clients and contractors.	[29]
Absence or lateness of construction workers in the morning.	[29]

Due to the existence of these challenges, construction organisations need to adopt measures that will ensure that the adopted safety initiative is effectively implemented. Hinze and Gambatese [33] have submitted that the most embraced safety initiatives among construction organisations offer safety incentives [33]. This is because these incentive schemes have the ability to not only improve safety performance but also motivate workers to be safe on sites [34]. Using safety incentive schemes that allow the use of prizes and gifts as rewards for good safety performance is essential as tangible rewards are a powerful tool that drives workers to achieve better safety performance [35]. This approach has been seen to help improve workers' safety behaviour and reduce accidents at the workplace and in the end, improve the safety records for organisations that have adopted it [36,37]. More so, Li and Poon [25] and Choi et al. [29] have noted that the best strategies to implement SWC successfully will be to establish a reward scheme to encourage workers and subcontractors who participate in the SWC activities. This can be in cash rewards and certificates of appreciation, among other forms of tangible rewards. This submission was affirmed by Chan and Choi [23], who noted that the use of reward systems could help motivate workers to be effective in SWC activities, and this can help combat the poor workers' attitudes to safety that seem to be deterring the effective implementation of safety initiatives. Moreover, to prevent rush jobs that might hamper the use of SWC, Choi et al. [29] suggested that adequate time must be allotted to each activity, and overall completion time must be reasonable. Ozaka [15] has earlier noted that the SWC is designed to ensure that proper safe work habits are cultivated among workers on site. As such, the continuous education of site workers is essential to help cultivate this safety habit over a while [23,38,39]. Furthermore, because SWC is not mandatory for all type of works, Chan and Choi [23] suggested that legislation to enforce its use in both private and public projects is essential for effective implementation. Other measures assessed in the current study are presented in Table 2.

Table 2. Summary of the effective measures for improving the implementation of SWC in the construction industry.

Measures for Improving SWC Implementation	Sources
Establish a reward scheme for workers participating in SWC.	[23,29]
Implement an award system to reward good-performers.	[23,25,29]
Engage professional aerobic trainers to lead the pre-work physical exercise.	[23]
Tailor-make daily cycle of SWC for a specific site according to the site activities and conditions.	[23]
Enforce SWC mandatorily to all new construction projects through legislation, whether public sector or private sector.	[23]
Review regularly the effectiveness of SWC during weekly or monthly safety meetings.	[23]
Provide more financial support to clients (public and private).	[19,23]
Provide suitable training to frontline safety officers and supervisors to launch SWC.	[23,38,39]
Employers should allocate adequate budget in contracts to perform the necessary items in SWC as a contractual requirement, especially in the private sector.	[19,23]
Compile a reasonable project schedule to avoid rush jobs.	[23,29]

3. Research Methodology

The study was quantitative, with a well-structured questionnaire used as an instrument for data collection. The questionnaire was adopted on the premise that it allows a larger sample to be reached within a limited time frame [40,41]. Moreover, previous safety studies within the AEC industry have adopted this approach in the quest to unearth H&S issues [17,23]. The questionnaire survey spanned two months from October to November of 2020 and was conducted among professionals that have participated in public construction projects using SWC. At the outset of the survey, determining the exact number of professionals that have participated in construction projects using SWC in Hong Kong was impossible, hence, gaining the exact target population for the study was difficult. As such, the study relied on the snowball sampling technique, wherein a professional that has used SWC refers other colleagues that have also used the SWC. The snowball sampling method is a referral process where few identified participants that fit into the defined category of a study are approached to partake in the survey and also recommend others that they know fit into the defined category. This referral process has been observed to help increase the rate of responses in research studies, wherein the target population cannot be determined from the very beginning [42,43]. Based on the snowball sampling method, 197 questionnaires' feedback was gathered through electronic means and was perceived to be sufficient for this study. It has been noted that the larger the sample, the more representative and reliable the result will be [44].

The questionnaire used was developed in sections with the first section harnessing information about the respondents' personal background. Section two gleaned the perceptions on the identified challenges associated with the use of SWC on construction projects, while section three strived to unearth possible improvement solutions towards effectively adopting SWC in construction projects. The variables used in sections two and three were gathered from extant literature and assessed on a five-point measurement scale of agreement, where 'five' represented 'strongly agree' whereas 'one' denoted 'strongly disagree'. The data on the personal information of the survey participants were reviewed and categorised using frequency and percentage values, while the variables on the perceived challenges of implementing SWC and the possible concomitant solutions were positioned in descending order according to the mean item score (MIS). In cases where two or more variables have the same MIS, the same rank number was assigned to both variables.

Furthermore, to gain a clearer perspective of the potential difficulties and possible solutions for implementing SWC, the individual views of the client organisations (represented by professional officials within the government works departments responsible for the delivery of public building and infrastructure development projects) and contractors were taken into account, and the results were presented accordingly. This was attributed to the fact that both the clients and contractors are primary game players in the implementation and enforcement of safety initiatives on construction projects. The Mann–Whitney U-Test (*M*–*W*)—a non-parametric alternative of ANOVA [45]—was employed to ascertain the significant difference in the responses from the clients' and contractors' respondents. The findings of the *M*–*W* test were further reinforced through the use of a Spearman's rank correlation test. This test helps ascertain the extent of the relationship between the rating of the clients' and contractors' groups. The Kendall's coefficient of concordance (*W*) and chi-square (χ^2) value were used to confirm the agreement level between respondents. This was performed through proper consideration of the differences in the mean of the variables. Moreover, the different variables assessed under the identified challenges of implementing SWC and the possible bolstering solutions were further analysed through exploratory factor analysis (EFA) after meeting all necessary preliminary estimates. EFA was applied to rearrange and group the individual factors into more manageable subgroups that are easy to define based on their common latent characteristics [45–47].

4. Results of Industry-Wide Survey

4.1. Background Information of Survey Respondents

From the 197 valid samples received in this study, Figure 1 shows that 48.7% of respondents were representatives from main contractors while 46.7% were from client organisations (largely from the government works departments). Only 4.1% and 0.5% of the responses were gathered from trade subcontractors and project consultants (e.g., architects, engineers, surveyors, and project managers), respectively. Because the main contractors are the implementors of SWC and clients give instruction and evaluation of the performance of SWC implemented by the main contractors, this, therefore, implies that the data gathered project the view of the principal actors of the implementation of safety initiatives on construction projects.

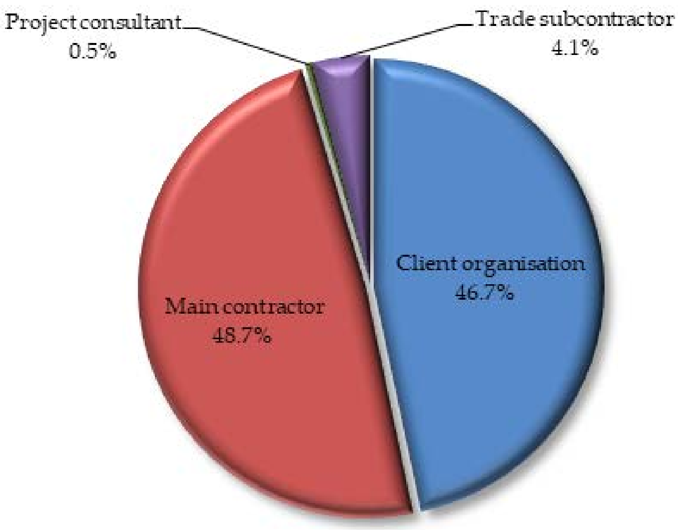

Figure 1. Organisation types of survey respondents.

Figure 2 shows that of the 197 responses gathered, more responses came from respondents at project management level (49.2%), site supervisor level (39.1%), and senior management level (11.2%). On the other hand, only 0.5% of responses was gathered from respondents at the workforce level (i.e., frontline workers at construction sites). This result implies that considerable input was gained from respondents who are in the majority from site supervisory level or above and are mostly in charge of managing the SWC on sites. Moreover, significant input was gained from senior management and project management level respondents responsible for allocating resources needed for the implementation of SWC and the decision on the approaches of executing and monitoring SWC.

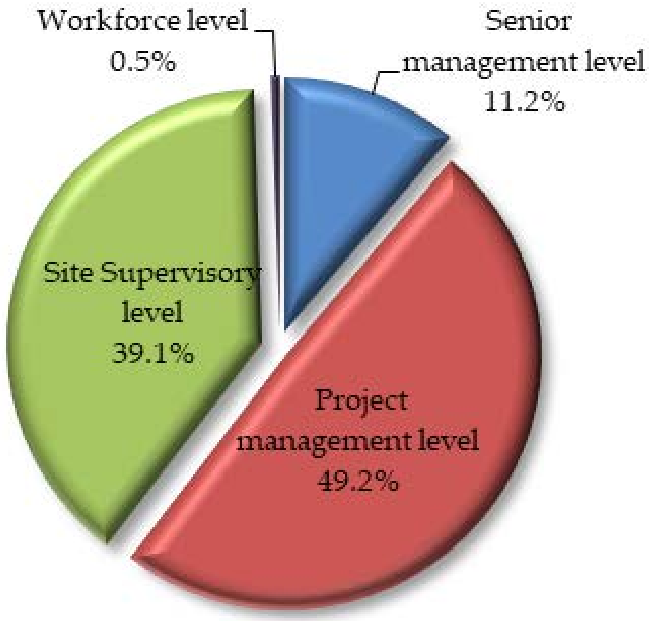

Figure 2. Respondents' working role within the organisation.

Regarding the duration of working experience, Figure 3 shows that a higher percentage of the respondents (79.2%) have above five years of working experience in the construction industry while only 20.8% have recorded below five years. Further analysis shows that respondents for the study can boast a combined average of 14 years of working experience in construction. Further analysis in Figure 4 shows that the considerable years of experience these respondents have amassed has influenced the number of SWC projects they have been involved in over the years. The figure shows that while 65.5% of respondents have worked on up to four projects in which this initiative was used, the remaining 34.5% have worked on between one and three SWC projects. On average, the respondents combined have worked on at least six construction projects where SWC was implemented.

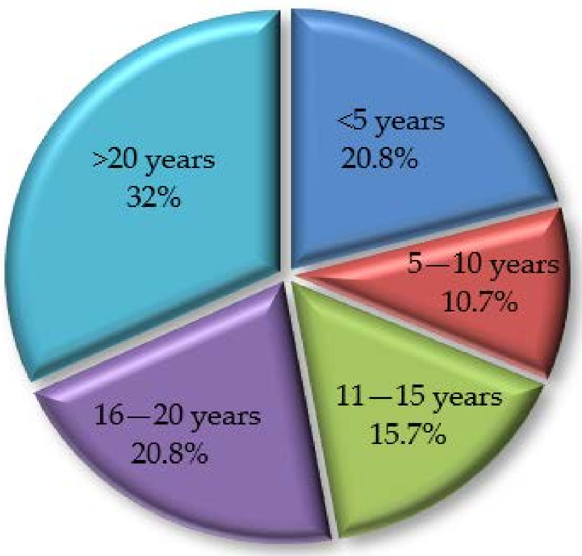

Figure 3. Working experience of the respondents in the construction industry.

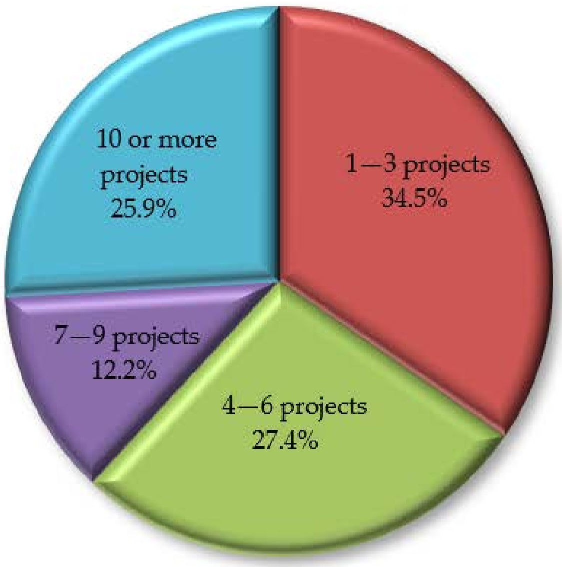

Figure 4. Working experience of the respondents in SWC construction projects.

Figure 5 gives the reason for implementing SWC, as indicated by the respondents. According to the result, 72.6% find the major reason for implementing SWC to be contractual requirements. This can be as a result of the fact that most of these respondents have largely worked on public projects and these initiatives are mandatory for these types of projects. The result further shows that 16.7% of the respondents noted SWC initiative was executed on a voluntary basis on their projects, and 6.1% noted that the combination of contractual requirement and voluntary basis led to the use of SWC. Only 4.6% were uncertain why to implement SWC. These categories of respondents were found with less working experience in the construction industry and currently worked at junior levels, including workforce and site supervisory levels.

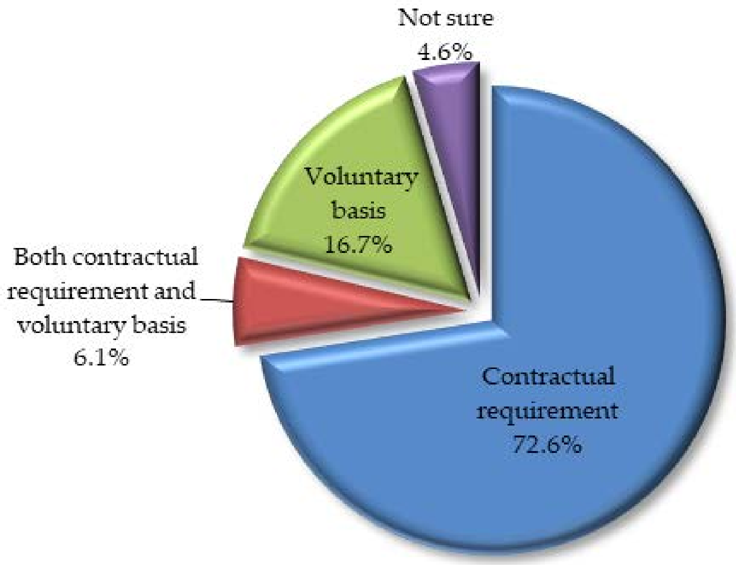

Figure 5. Reasons for implementing SWC in the construction industry.

4.2. Challenges of Implementing Safe Working Cycle in Construction

In determining the difficulties facing the successful implementation of SWC on construction projects in Hong Kong, the respondents in the study were provided with nine major difficulty variables unearthed from the review of related studies. The respondents ranked these nine variables on a five-point agreement scale, and the results as ranked by those from the client, contractor, and overall responses are portrayed in Table 3. The table also summarises the result of the *M–W* test, Kendall's *W* test, and χ^2 test conducted. The result in the table shows that the respondents from the clients noted that the absence of motivating factors to encourage participation in SWC is the major difficulty encountered with the effective implementation of SWC. Those from the contractors' group, however, had a divergent view regarding the most crucial difficulties as they ranked tight project schedule as the top difficulty. *M–W* test further confirmed this disparity in rating this difficulty by both groups as a significant *p*-value of 0.004 was obtained. On the overall rating, all the respondents indicated that "over-tight project schedule leading to rush jobs" was considered as the most difficult obstruction for the adoption of SWC as this variable had the highest MIS of 3.74. They also rated "irregular working schedule for different trades at various stages of projects" (MIS = 3.71) and "lack of motivation for workers to participate in SWC" (MIS = 3.71) as the second most challenging difficulties encountered in SWC adopted construction projects. The least difficult was "unfamiliarity with SWC by clients and contractors" with an MIS of 2.99. This is understandable as the background information already shows that construction participants in Hong Kong are already conversant with the concept of SWC. The *M–W* test manifested a considerable disparity in the perception of the survey participants from the clients' and contractors' groups in rating four out of the nine assessed difficulties. These four variables had a *p*-value of lower than the 0.05 cut-off. However, the derived χ^2 value from Kendall's *W* test gave a calculated χ^2 value of 139.74 for all respondents, and this is greater than the critical χ^2 value of 15.51 derived from a statistical table. Therefore, it can be advocated that despite the disparity derived in the four variables from the *M–W* test, in general no significant discrepancy exists in the ranking by the respondents [48].

Table 3. Descriptive and inferential statistics of the perceived challenges of implementing SWC.

	All		**Client**		**Contractor**		***M–W* Test**	
Challenges of Implementing SWC	**MIS**	**R**	**MIS**	**R**	**MIS**	**R**	**Z-Value**	**Sig.**
Over-tight project schedule leading to rushed jobs.	3.74	1	3.48	3	3.94	1	−2.906	0.004 **
Irregular working schedule for different trades at various stages of projects.	3.71	2	3.6	2	3.82	2	−1.752	0.080
Lack of motivation for workers to participate in SWC.	3.71	2	3.62	1	3.78	3	−1.263	0.206
Resistance from subcontractors and workers to participate if the training venue is far away from job site.	3.57	4	3.37	4	3.77	7	−2.651	0.008 **
Limited site space to conduct morning physical exercise or activities.	3.44	5	3.18	6	3.66	5	−3.226	0.001 **
Insufficient financial support to cover necessary SWC items.	3.35	6	3.03	8	3.62	6	−3.657	0.000 **
Absence or lateness of construction workers in the morning.	3.29	7	3.21	5	3.34	8	−1.442	0.149
Inadequate education or promotions from government.	3.22	8	3.14	7	3.35	7	−1.259	0.208
Unfamiliarity with SWC by clients and contractors.	2.99	9	2.99	9	2.96	9	−0.084	0.933
Kendall's *W*	0.091		0.071		0.132			
Actual χ^2 value	139.74		50.87		99.55			
Critical χ^2 value from statistical table	15.51		15.51		15.51			
df	8		8		8			
p-value	0.000		0.000		0.000			

MIS = Mean score; R = Rank; χ^2 = Chi square; df = Degree of freedom; Sig. ** = *p*-value less than 0.05.

The Spearman's rank correlation test was adopted to test the correlation between the ratings from the two major groups of respondents (client and contractor). According to Pallant [45], the Spearman's rank correlation test is ideal for identifying the extent of the relationship between two continuous variables. For this test, a null hypothesis (H_0), which states that no significant relationship exists between the two groups of respondents (clients and contractors), was set. Conversely, the alternate hypothesis (H_a) was that a significant relationship exists between the rankings from both groups. The premise for rejecting the H_0 is that the derived p-value must be less than the conventional 0.05 threshold. The reverse is the case if the derived p-value is greater than 0.05. The result from Table 4 reveals that the derived p-value was less than the allowable value of 0.05. Therefore, the contractors' and clients' views were correlated and the result is a true reflection of the difficulties faced in implementing SWC in construction projects. Based on this result, H_0 is rejected, and H_a is accepted.

Table 4. Spearman's rank correlation test results on the perceived challenges of implementing SWC.

Comparison of Rankings	r_s	p-Value	Remark
Client vs. Contractor	0.695	0.038	Reject H_0 at 5% significance level

The nine difficulties were further analysed with EFA through principal factor analysis with Promax rotation. The use of EFA allowed the reduction of these difficulties into smaller clusters that can be renamed for clarity [45]. Preliminary tests conducted before EFA include the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity (BTS). Ideally, the derived KMO value must be above 0.6, and BTS must be significant at a p-value < 0.05 for the data to be considered for EFA [45,49]. The result shown in Table 5 revealed a KMO value of 0.776 and a significant p-value of 0.000 for the BTS test. This result, along with the large sample size of 197 of the study, affirms the suitability of the data for EFA. The conducted principal factor analysis revealed two distinct groups with their eigenvalues greater than one. As such, the nine difficulties are considered to have latent similarities that can be grouped into two distinct clustered factors. These two factor groups account for 68% of the cumulative percentage of variance explained, which is more than the 50% threshold set by past research studies [50]. This means that difficulties identified in the two factor groups are the leading issues facing the implementation of SWC in construction projects.

Table 5. Principal factor analysis results of the perceived challenges of implementing SWC.

Challenges of Implementing SWC	Factor Loading	Eigenvalue	% of Variance Explained	Total % of Variance Explained
Factor 1—Tight project schedule and limited site space				
Resistance from subcontractors and workers to participate if the training venue is far away from job site.	0.823	3.224	45.8	45.8
Irregular working schedule for different trades of workers at various stages of projects.	0.764			
Over-tight project schedule leading to rushed jobs.	0.726			
Limited site space to conduct morning physical exercise or activities.	0.590			
Factor 2—Lack of promotions and support for SWC implementation				

Table 5. *Cont.*

Challenges of Implementing SWC	**Factor Loading**	**Eigenvalue**	**% of Variance Explained**	**Total % of Variance Explained**
Inadequate education or promotions from government.	0.746	1.459	22.2	68.0
Unfamiliarity with SWC by clients and contractors.	0.720			
Insufficient financial support to cover necessary SWC items.	0.685			
Lack of motivation for workers to participate in SWC.	0.635			
Absence or lateness of construction workers in the morning.	0.543			
KMO value	0.776			
BTS				
Approximate χ^2 value	415.09			
df	36			
p-value	0.000			

The first extracted factor group accounts for the highest percentage variance of 45.8% and has four variables with a factor loading of above 0.5 loading on it. The variables include workers' resistance on the grounds of the far distance between training ground and job site (82.3%), irregular working times for different construction activities (76.4%), tight project schedule (72.6%), and site space constraint for workouts (59%). This factor group was subsequently named 'tight project schedule and limited site space' due to the inherent similarities in these variables. The second extracted factor group accounts for 22.2% of the variance explained and carries the remaining five variables loading. These include the inadequate promotions and education from the government (74.6%), unfamiliarity with SWC by clients and contractors (72%), inadequate financial support (68.5%), absence of motivating factors to encourage participation in SWC (63.5%), and absence or lateness of construction workers in the morning (54.3%). This factor group was further named 'lack of promotions and support for SWC implementation' based on the latent similarity of the variables loading.

4.3. Bolstering Measures for Improving the Implementation of Safe Working Cycle in Construction

In assessing the measures needed to improve the effective use of SWC in construction projects, ten variables were identified from the desktop review and dispatched to the respondents to rate according to their level of agreement. The result of this rating is presented in Table 6 along with the result from the *M–W* test, Kendall's *W* test, and χ^2 test conducted. The results show consistency among the two groups of respondents regarding the top two measures that can help promote the use of SWC. Both groups rated 'reward good performers through diverse award systems' (MIS = 4.24) and 'allow a reasonable project schedule for projects' (MIS = 4.16) as the two most useful measures for SWC to improve the site safety performance. It is important to have a reward system such as joining external safety campaigns or organising internal safety promotion activities, which could include but is not limited to the best safety model worker award, best safety officer and supervisor award, best SWC site award, and best project manager and site agent award. These reward systems could motivate the employees in participation of safety issues and enhance their safety awareness. However, these reward systems will not be materialised without their associated costs for implementation on the project. Basically, the costs associated with the requisite activities of SWC execution under the pay-for-safety scheme (PFSS) should be included in the contracts of all construction projects with a budget allocation of no more than 2% of contract sum by the contractors during tender submission. Therefore, supporting the use of these reward systems with other recommended measures such as compiling a reasonable project schedule that will allow construction workers to maintain deliberate pace is essential. This will also allow the rush of jobs on projects to be avoided and help eliminate issues surrounding tight project schedules, which is a critical challenge affecting the implantation of SWC, as is evident in Table 3. The *M–W* test indicated a profound disparity in the opinions between the clients' and contractors' groups in rating two of the ten proposed measures. These two measures had a *p*-value of lower than the 0.05 cut-off. However, the derived χ^2 value from the Kendall's *W* test gave a calculated χ^2 value of 225.91 for all respondents, and this is greater than the critical χ^2 value of 16.92 derived from a statistical table. Following this result, it can be concluded that despite the disparity derived in the two measures from the *M–W* test, in general no significant discrepancy exists in the ranking by the respondents.

Table 6. Descriptive and inferential statistics of the effective measures for improving the implementation of SWC.

Measures for Improving SWC Implementation	All		Client		Contractor		*M–W* Test	
	MIS	R	MIS	R	MIS	R	Z-Value	Sig.
Implement an award system to reward good-performers.	4.24	1	4.18	1	4.29	1	−1.335	0.182
Compile a reasonable project schedule to avoid rushed jobs.	4.16	2	4.09	2	4.25	2	−1.519	0.129
Establish a reward scheme for workers participating in SWC.	4.13	3	4.03	3	4.20	4	−1.559	0.119
Employers should allocate adequate budget in contracts to perform the necessary items in SWC as a contractual requirement, especially in the private sector.	4.08	4	3.97	5	4.19	5	−2.118	0.034 **
Provide more financial support to clients (public and private).	3.99	5	3.76	8	4.21	3	−3.991	0.000 **
Provide suitable training to frontline safety officers and supervisors to launch SWC.	3.97	6	4.01	4	3.9	6	−1.133	0.257
Review regularly the effectiveness of SWC during weekly or monthly safety meetings.	3.86	7	3.92	7	3.82	7	−1.088	0.277
Tailor-make daily cycle of SWC for a specific site according to the site activities and conditions.	3.85	8	3.93	6	3.77	8	−1.532	0.126
Enforce SWC mandatorily to all new construction projects through legislation, whether public sector or private sector.	3.56	9	3.57	9	3.57	9	−0.178	0.858
Engage professional aerobic trainers to lead the pre-work physical exercise.	3.39	10	3.27	10	3.49	10	−1.524	0.127
Kendall's *W*	0.129		0.153		0.146			
Actual χ^2 value	225.91		122.74		126.34			
Critical χ^2 value from statistical table	16.92		16.92		16.92			
df	9		9		9			
p-value	0.000		0.000		0.000			

MIS = Mean score; R = Rank; χ^2 = Chi square; df = Degree of freedom; Sig. ** = *p*-value less than 0.05.

Table 7 reveals the result of the Spearman rank correlation test conducted on the effective measures for improving the use of SWC. The H_0 set for the test is that no significant relationship is found between the two groups of respondents (clients and contractors). The result in the table indicated a significant relationship between the client and contractor's group on the measures for improving the use of SWC as a *p*-value less than 0.05 was derived. Based on this result, the H_0 is rejected. Therefore, it can be concluded that the effective measures proposed in the study are a true reflection of what is needed to improve the use of SWC for the better site safety performance of construction projects.

Table 7. Spearman's rank correlation test on the effective measures for improving the implementation of SWC.

Comparison of Rankings	r_s	*p*-Value	Remark
Client vs. Contractor	0.794	0.006	Reject H_0 at 5% significance level

The ten effective improvement measures assessed were also analysed with EFA. The preliminary analysis gave a KMO value of 0.836 and a significant *p*-value of 0.000 for the BTS test, thus affirming EFA to be appropriately used for the data gleaned. The conducted principal factor analysis revealed three distinct factor groups with their eigenvalues larger than one, as seen in Table 8. As such, the ten measures are considered to have latent similarities that can be grouped into three distinct factor groups. These three factor groups accounts for about 74% of the cumulative percentage of variance explained. This means that the measures identified in the three grouped factors are the leading measures needed to effectively implement SWC in construction projects. The first extracted factor group accounts for the highest percentage variance of 40.5% and has three variables with a factor loading of above 0.5 loading on it. The variables include adequate budget allocation for SWC in contracts (77.4%), allowing a reasonable project schedule for projects (74.3%), and clients should provide financial support for SWC execution (67.4%). This factor group was subsequently named 'adequate budget allocation and reasonable project schedule' due to the inherent similarities in these three variables. The second extracted factor group accounts for 22.5% of the variance explained and carries two variables loading including rewarding good performers through diverse award systems (87.9%) and establishing a reward scheme for workers participating in SWC (86.0%). This factor group was labelled 'establishment of a reward system towards construction workers' with reference to the latent similarity of the two variables loading on it. The last extracted factor group accounts for 10.9% of the variance explained and carries four variables loading on it. These variables consist of the use of professional trainers to lead the pre-work physical exercise (67.8%), the design of daily cycle should be site-specific considering the site activities and conditions (66.6%), afford frontline safety officers and supervisors suitable training to launch SWC (63.2%), and regular review of SWC effectiveness by senior site staff (56.6%). This factor group was labelled 'development of a tailor-made SWC system for each specific construction site' due to the similarities in the variables loading on it.

Table 8. Principal factor analysis results of the effective measures for improving the implementation of SWC.

Item	Factor Loading	Eigenvalue	% of Variance Explained	Total % of Variance Explained
Factor 1—Adequate budget allocation and reasonable project schedule				
Employers should allocate adequate budget in contracts to perform the necessary items in SWC as a contractual requirement, especially in the private sector.	0.774	1.946	40.5	40.5
Compile a reasonable project schedule to avoid rushed jobs.	0.743			
Provide more financial support to clients (public and private).	0.674			
Enforce SWC mandatorily to all new construction projects through legislation, whether public sector or private sector.	0.418			

Table 8. *Cont.*

Item	Factor Loading	Eigenvalue	% of Variance Explained	Total % of Variance Explained
Factor 2—Establishment of a reward system towards construction workers				
Implement an award system to reward good-performers.	0.879	1.852	22.5	63.0
Establish a reward scheme for workers participating in SWC.	0.860			
Factor 3—Development of a tailor-made SWC system for each specific construction site				
Engage professional aerobic trainers to lead the pre-work physical exercise.	0.678	1.793	10.9	73.9
Tailor-make daily cycle of SWC for a specific site according to the site activities and conditions.	0.666			
Provide suitable training to frontline safety officers and supervisors to launch SWC.	0.632			
Review regularly the effectiveness of SWC during weekly or monthly safety meetings.	0.566			
KMO value	0.836			
BTS				
Approximate χ^2 value df *p*-value	404.643 45 0.000			

5. Discussion of Survey Findings

The study findings manifested that SWC is embraced in the Hong Kong construction industry, particularly in the delivery of public projects. However, its effective implementation still faces significant challenges that can be grouped into two viz; (1) schedule and space constraints and (2) promotion and support for SWC. The need for space has been a continuous problem hindering the effective use of safety initiatives such as SWC and PFSS [29]. Mendis et al. [19] have also made a similar observation in Sri Lanka, where the absence of adequate space to train and conduct meetings is an issue for effective SWC. These findings are in tandem with the submissions of Chan and Choi [23] on the need for adequate time for delivery of projects to avoid rushed jobs and the neglect of SWC functions. This is because the tight timelines of construction activities make it difficult for SWC to be fully implemented on construction projects. In addition, Li and Poon [25] have earlier noted that as a result of the distance between training venues and construction sites, workers tend to resist participating in SWC activities, and this slows down the whole process of attaining better safety performance. In terms of promotion and support for SWC, it is believed that inadequate promotions of SWC by the government, inadequate financial support, and lack of motivating factors to encourage participation in SWC can hamper the effective implementation of SWC systems. This further affirms past submissions that have noted that when the budget does not cater for the expenses required for the activities in the SWC, the successful implantation of the initiative would be almost impossible [23,31]. Moreover, without proper support from the government through education and promotion of the concepts, encouraging people, particularly private sector clients, to embrace these concepts will become difficult. This observation further echoes the submissions of Chan and Choi [23] on the need for the government to promote this safety initiative through legislation with a view to better improve safety performance.

In terms of improving the use of SWC to attain better safety performance, the study revealed some bolstering measures that require careful attention on the part of construction organisations and industry participants. These measures can be categorised into three main groups (1) adequate budget and schedule allocations, (2) use of reward system, and (3) a tailor-made SWC system. The challenges of implementing SWC include issues around budget and schedule. Therefore, it is logical for organisations and project participants to ensure that these parameters are considered from the onset of conceptualising the project. Without adequate provision for SWC in the budget and allowing adequate time for SWC activities in the project timeline, effectively implementing this initiative will be a problem. Thus, carefully designing the project schedule and budget and making an allowance for SWC activities will go a long way in eliminating schedule and budget issues, as observed in the challenges facing SWC implementation in this study. This finding supports the submissions of Chan and Choi [23] and Choi et al. [29] on the recommendations for effective SWC implementation. Moreover, the study found the use of a reward system as a viable option for promoting and motivating workers and subcontractors to participate in SWC activities. Hinze and Gambatese [33] have earlier noted that the use of safety initiatives with incentive schemes has been widely embraced by construction organisations to ensure successful site safety. These incentives schemes are highly effective for achieving safe working environments [51]. Thus, construction organisations seeking to improve their safety performance through SWC can adopt tangible rewards for good safety performance and participation in the SWC activities by workers. Through these reward systems, they can help shape their workers' behaviours towards site safety [36,37], which unfortunately has been noted to be an issue facing safety on construction projects [23,30,31]. Lastly, to improve the adoption of SWC, a tailor-made SWC system for each specific construction site is required. Chan and Choi [23] have witnessed the need for a carefully designed fit-for-purpose SWC system that accommodates the specific site based on the diverse site activities and conditions required. Choi et al. [29] made a similar observation on carefully designing the SWC activities to fit the project. This will help eliminate the issue of insufficient site space that is a profound challenge to the successful implementation of SWC in most projects.

6. Conclusions

Conclusively, the issue of safety on construction sites is a critical issue that will continue to garner significant attention among industrial practitioners and academics as a result of the important nature of preserving the construction workforce. The construction industry in Hong Kong has recognised this fact, and several safety initiatives have been embraced to drastically reduce the rate of construction site accidents. In addition, safety initiatives such as the SWC have been introduced, particularly in public sector construction projects. However, certain significant challenges still hinder the effective implementation of this SWC initiative. Based on the survey findings, these major challenges can be classified as schedule and space constraints as well as insufficient promotions and support for SWC execution. The study also recommended that the effective concomitant measures relating to adequate budget and schedule allocations, adoption of reward system, and a tailor-made project-specific SWC system, are essential in combating these challenges.

This study has provided strong empirical evidence in the profound challenges encountered with SWC implementation and suggested possible effective solutions required to achieve the successful execution of this safety initiative within the Hong Kong construction industry. Therefore, the survey findings can prove useful and effective towards the owners and top management of construction organisations, senior officials of government work entities responsible for the delivery of building and infrastructure development projects, and policymakers in determining and understanding the prevailing difficulties that can create potential hindrances to the successful implementation of SWC in the quest for improved site safety performance. Furthermore, the recommended bolstering measures can help to achieve the smooth execution of SWC within the construction industry as a whole. Theoretically, the findings have contributed to the existing discourse on construction site safety. As not much focus has been placed on SWC in existing research studies, this paper offers future researchers seeking to explore SWC a platform to build on. Despite these significant contributions, special care needs to be taken in generalising the research outcomes due to some specific limitations. For instance, SWC has been regarded to be a common safety initiative used in public works projects, and most of the respondents for this study were drawn from public sector projects. Therefore, it is suggested that future research work can explore the associated challenges and measures needed for improving the use of these safety initiatives such as SWC in private building projects. Furthermore, the study employed a snowball sampling approach, which implies that the findings may not be fully generalised as some professionals that have participated in SWC projects in the past might not have been included in the current study. Future research studies can adopt other sampling approaches to garner more opinion data that can be representative of the entire population of professionals that have adopted SWC in their construction projects. Moreover, the respondents for this study have worked in diverse types of construction projects. Further research studies can be conducted towards those industrial practitioners engaged in specific types of construction projects or on a case-study basis of some specific projects within Hong Kong and other countries where such studies are either deficient or non-existent.

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